THE

Emporium

OF

ARTS & SCIENCES.

Vol. I.

Conducted by

John Redman Coxe M.D.

Professor of Chemistry
in the University of Pennsylvania.

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THE
EMPORIUM
OF
ARTS AND SCIENCES.

DISTRICT OF PENNSYLVANIA, To WIT:

BE IT REMEMBERED, That on the first day of May, in the thirty-sixth year of the Independence of the United States of America, A. D. 1812, Joseph Delaplaine, of the said district, hath deposited in this office the title of a book, the right whereof he claims as Proprietor, in the words following, to wit:

"The Emporium of Arts and Sciences. Vol. I. E Pluribus Unum. Conducted by John Redman Coxe, M. D. Professor of Chemistry in the University of Pennsylvania."

In conformity to the act of the Congress of the United States, intituled, "An act for the encouragement of learning, by securing the copies of Maps, Charts, and Books, to the Authors and Proprietors of such copies during the times therein mentioned."—And also to the act, entitled, "An act supplementary to an act, entitled "An act for the encouragement of learning, by securing the copies of Maps, Charts, and Books, to the Authors and Proprietors of such copies during the times therein mentioned," and extending the benefits thereof to the arts of designing, engraving, and etching, historical and other prints."

D. CALDWELL.
Clerk of the District of Pennsylvania.

PROSPECTUS

OF

THE EMPORIUM

OF

ARTS AND SCIENCES.

In the present state of society, it would, beyond a doubt, be considered a work of supererogation, to point out the connexion of human happiness with an extension of knowledge. If knowledge be thus eminently beneficial, is it not our interest, as it assuredly is our duty, to promote its diffusion amongst us? It is a fortunate circumstance, that we rarely find so great a degree of ignorance in our extensive territory, as exists in many regions much older in the annals of history; on the contrary, it is remarkable, that notwithstanding the scattered state of our population, our citizens are better informed and have fewer prejudices than any people upon the globe. Liberty, the surest pledge of free inquiry, is one prime source of the advantages we enjoy. Unfettered in our press—unshackled in our conscience, man here possesses means of happiness as perfect as is consistent with his nature. From the same cause, no doubt, in part arises that ingenuity which is so conspicuous in the American character. Few nations can boast of more improvements in labour-saving machinery, than have been discovered in the progress of the mechanical arts amongst us. We are, however, but young in practical information on numerous

points, in which our highest interests are concerned. To aid our researches, we still require that solid information arising out of extensive operations and experience, which European cotemporaries are continually affording.

Let it not be said, we have the books amongst us from which these treasures may be culled! To be extensively useful, they must be widely disseminated; but this is not to be effected by a few imported copies. Our own presses must diffuse their contents, or they will continue to perish upon the shelves of individuals, or in our public libraries! Independently too of this consideration, much foreign matter, useless to our country, adds greatly to the expense of the imported works in question.

France, that imperial Colossus, has evinced by her present existence, the truth of the maxim, that "Knowledge is power." At the period in which she was threatened with the inroads of foreign enemies, her means of defence were poured in profusion from domestic sources into her lap, by the skilful operations of a few scientific men. Nitre, the chief constituent of the means of war, was abundantly formed by their directions, when all foreign sources were completely dried up: And to this period, the greater part of her powder is supplied from the products of her own soil.—How long did the scientific operations of Archimedes baffle the attacks of the veteran bands of Rome! Surely, then, reason and sound public policy will dictate the encouragement of a diffusion of knowledge, on which, perhaps, at some future day, the very destinies of our country may depend.

The Emporium professes to be a source of *practical information in the various branches of scientific research*, and is intended to convey the rich harvest of *facts*, con-

tained in foreign valuable papers on *Chemistry, Mineralogy, Natural Philosophy, Arts, Sciences,* and *Agriculture,* with the proper cultivation of which, undoubtedly the truest interests of every country, but especially our own, are closely connected.

We might expatiate, largely, on the great utility of such a work, but this would be unnecessary, since our numerous artists and manufacturers will readily perceive that they may derive from it the plainest and easiest means to lessen labour and unnecessary application. In some it will awaken reflection on a favourite pursuit; new sources of industry and emolument will be pointed out to others, and the practical knowledge of many will receive improvement and unexpected aid. Standing, as it were upon the shoulders of our transatlantic rivals, we may hope to catch new views of the prospect before us, which will enable us to shorten the road to ultimate perfection.

In this work, Science, which is of no party, will equally distribute her favours to all. It is avowedly a work of practical utility, in which all are equally concerned. Its object is to make that ours, which may subserve both public and private interest. To practical information all other objects are merely secondary; speculative opinions will therefore as seldom as possible be obtruded.

A selection will appear in the Emporium, which will render it a kind of *text book* to our citizens, and which, if successfully continued, it is hoped will prove a valuable library of useful knowledge to every class of society.

Although what has been mentioned will form the prominent features of our publication, it is intended likewise

to preserve on its pages, such insulated facts as may hereafter prove useful. Miscellaneous observations of practical tendency, together with several minor, though not uninteresting subjects of information, will, it is expected, afford a repast to all persons who feel interested in the advancement of science.

Notwithstanding it is designed principally to attend to the progressive state of science in Europe, from whence we must reasonably look for information for many years to come, yet original papers of our country of real merit, and of practical tendency, will at all times be cheerfully received, and promptly communicated to the public.

Of the manner in which this work will be conducted, it becomes the Editor to be silent. Industry will not be wanting, if health permits. Of the labour attending it, he is in some degree qualified to judge, from having conducted a periodical work on medicine to the extent of several volumes. It is his intention to persevere in this undertaking as long as he may be favoured with public patronage, and if he can through it contribute to the interests of his country, his fondest wishes will be accomplished.

JOHN REDMAN COXE.

Philadelphia, April 1, 1812.

THE

EMPORIUM

OF

ARTS AND SCIENCES.

VOL. I.] MAY, 1812. [No. 1.

The following communication to Mr. Nicholson is so well adapted to the present work, that it may serve the purpose of a more diffuse and laboured Introduction. EDITOR.

No. 1.

*On the utility of Scientific Periodical Publications—In a Letter to Mr. Nicholson.**

DEAR SIR,

THE advantages derived from scientific periodic publications, are an acquisition which former philosophers were not possessed of; and it was not until the last century they were first instituted. The rapid progress of science and information since that period, would be a sufficient argument in favour of their decided utility, without any reference to systematic treatises published, of undoubted merit, and sanctioned by universal approbation.

To the active and ingenious mind in early life this mode of information is invaluable. Besides furnishing new ideas to the young student, they point out the pre-

* Philosophical Journal, vol. 13. p. 72.

cise state of the different branches of human knowledge; they teach him the necessary caution for conducting experiments with vigour and accuracy, instead of drawing conclusions from a few insulated analyses, or imagining that his data are sufficiently perfect for establishing new systems. By reading these publications it is that he will enlarge his general conceptions, and will learn to emulate the various illustrious characters of all the enlightened countries of the world. In these treatises his views will not be confined to one object, but he will contemplate a scene continually varying. The physiology and phenomena of the animal and vegetable kingdoms; the actions and re-actions of the different elementary substances in nature, and their combinations with each other, will pass in succession under his observation.

The great physical laws which constitute and maintain the equilibrium of the world, are inserted in respectable works of this nature as they are discovered and demonstrated, while the errors of former philosophers are detected and exposed; by which means he has an opportunity of ascertaining the value and correctness of those works he may be already in possession of.

To those who consult an Encyclopædia for scientific matter, these publications are of indispensable utility, by continually pointing out the numerous improvements as they become public, and by that means the general system of philosophical knowledge is kept to the level of the existing state of discovery.

To the mechanic a repository of this kind must be highly useful, as the receptacle in which he may record his labours and improvements, and secure to himself the well-earned fame of his discoveries, at the same time that he derives advantage from others following his example in their contributions to the general fund of science.

In short, there is no class of individuals but may profit

from this method of extending useful knowledge. The small sum of seven-pence or eight-pence a week to any economical person is trifling, and there is no doubt but every inquirer will find something of which he may abridge himself, in order to become possessed of such an assemblage of facts and opinions. He is as it were making himself intimate with a class of men whose names will be read with admiration by a grateful posterity. It is only by familiarizing the mind with the sublime objects of science, and diffusing them over the face of the earth, that we can expect to establish that spirit of philanthropy and social order, which is so necessary to the happiness of the human race.

I am, &c. &c.

RICHARD WINTER.

No. 2.

As many of the papers which will appear in this work, will be derived from the English, French, and other periodical works of the continent of Europe, it becomes necessary, in order to understand the weights and measures, &c. to give the tables, with their corresponding value to those which we usually employ. These tables will with propriety occupy the first few pages of our work, to which reference can be at all times conveniently made. ED.

*Of English Weights and Measures.**

THE weights and measures required by the chemist are few and simple, but they should be accurate, and their relative values well defined.

* Aikin's Chemical Dictionary, vol. 2.

For the measure of weight, the Troy pound of 12 ounces, or 5760 grains, is the integer almost always preferred, being that which admits of a minuter subdivision, and whose correspondences with measures of capacity are more accurately defined; though there are still some slight differences in this respect which it were to be wished were removed by authority. The subdivisions of the Troy ounce employed by chemists are sometimes those of Apothecaries weight, that is, the ounce into 8 drams, the dram into 3 scruples, and the scruple into 20 grains, or more commonly, simply into drams and grains; or sometimes the ounce is divided into 20 pennyweights, and the pennyweight into 24 grains. Often the grain is the only integer employed, and sets of weights are used of the different hundreds, tens, and units. The averdupois pound is however sometimes adopted, being the standard of most things bought and sold in common life. It is equal to 7000 grains Troy, and is divided into 16 ounces, and the ounce legally into 16 drams, but the latter division is never used by chemists, being liable to be mistaken for the Troy dram, which weighs more than twice as much.

For measures of capacity, chemists employ both the *ounce measure* (or bulk occupied by the ounce, or any proportion of it, of distilled water at 60°) and the *cubic inch*. For larger quantities both the *Wine Pint*, of 28.875 cubic inches, and the *Ale Pint*, of 35.25 cubic inches, are used. Two pints make a *Quart*, and four quarts make a *Gallon*.

The correspondence between measures of weight and capacity is found by the weight of a cubic inch of water. In this however a slight difference exists, in authorities apparently equally worthy of confidence, which depends partly on the extreme difficulty of constructing instruments of perfect accuracy, and partly on some

slight discrepancy between the standards themselves. The extent of this difference is about half a grain in 253. We have adopted in the following Tables the estimations given by Sir G. Shuckburgh Evelyn, in the 88th vol. of the Philosophical Transactions, corrected in a subsequent paper by Mr. Fletcher, in the 4th vol. of the Philosophical Journal. On this calculation the cubic inch of distilled water at 60° therm. and 29.5 bar. weighs 252.506 grains Troy.

Hence we have the following equations.

	Cubic inch.		
1 ounce Troy of water at 60° occupies	1.900945		
	grs. Troy.	*lb. Troy.*	*lb. Averdu.*
1 Wine pint of water weighs	7291.11075 =	1.26581783 =	1.04158725
	grs. Troy.	*lb. Troy.*	*lb. Averdu.*
1 Ale pint of water weighs	8900.8365 =	1.545284 =	1.271548
	Wine pint.	*Ale pint.*	
1 lb. Troy of water occupies	.7900031 =	.6471302	
	Wine pint.	*Ale pint.*	
1 lb. Averdupois of water occupies	.960073 =	.7864429	

We may here notice the very common error of estimating a wine pint of water to be equal to 16 ounces Troy, since it wants as much as 389 grs. of 16 ounces, when the cubic inch is estimated at 252.506 grs. and 375 grs. when the cubic inch is reckoned at 253 grs. which is the highest estimation. Nevertheless as several measuring vessels are thus graduated, and as the adoption of this standard would be extremely convenient, this measurement may be often usefully employed for moderate quantities; but the chemist should then express that he uses the pint of 16 ounces Troy.

TABLE

For converting Cubic Inches of Water (at 60 Therm. and 29.5 Bar.) into their equivalents in Troy weight.

Cub. Inch of Water	*Troy grs.*	*oz.*	*dram*	*grs.*
1. weighs	252.506 =	0 :	4 :	12.506
2.	505.012 =	1 :	0 :	25.012
3.	757.518 =	1 :	4 :	37.518
4.	1010.024 =	2 :	0 :	50.024
5.	1262.530 =	2 :	5 :	2.530
6.	1515.036 =	3 :	1 :	15.036
7.	1767.542 =	3 :	5 :	27.542
8.	2020.048 =	4 :	1 :	40.048
9.	2272.554 =	4 :	5 :	52.554
1728. (1 cub. foot)	———	909 :	0 :	10.368

TABLE

For converting Troy grains, drams, ounces, and pounds of Water into their equivalent Cubic Inches.

Grain	*Cubic Inch*
1. =	.00396
2. =	.00792
3. =	.01188
4. =	.01584
5. =	.01980
6. =	.02376
7. =	.02772
8. =	.03168
9. =	.03564.

Dram	*Cubic Inch*
1. =	.237618
2. =	.475236
3. =	.712854
4. =	.950472
5. =	1.188090
6. =	1.425708
7. =	1.663326

Ounce	*Cubic Inch*
1. =	1.900945
2. =	3.801890
3. =	5.702835
4. =	7.603780
5. =	9.504725
6. =	11.405670
7. =	13.306615
8. =	15.207560
9. =	17.108505
10. =	19.009450
11. =	20.910395

Pound	*Cubic Inch*
1 =	22.81134
2 =	45.62268
3 =	68.43402
4 =	91.24536
5 =	114.05670
6 =	136.86804
7 =	159.67938
8 =	182.49072
9 =	205.30206

TABLE

For converting Wine Pints of Water into their equivalent Troy and Averdupois Pounds.

Wine Pts.	*lbs. Troy*	*lbs.*	*oz.*	*dr.*	*grs.*	*lbs. Averdu.*
1. =	1.26581783 =	1 :	3 :	1 :	31.1 =	1.04158725
2. =	2.53163566 =	2 :	6 :	3 :	2.2 =	2.08317450
3. =	3.79745349 =	3 :	9 :	4 :	33.3 =	3.12476175
4. =	5.06327132 =	5 :	0 :	6 :	4.4 =	4.16634900
5. =	6.32908915 =	6 :	3 :	7 :	35.5 =	5.20793625
6. =	7.59490698 =	7 :	7 :	1 :	6.6 =	6.24952350
7. =	8.86072481 =	8 :	10 :	2 :	37.7 =	7.29111075
8. =	10.12654264 =	10 :	1 :	4 :	8.8 =	8.33269800
9. =	11.39236047 =	11 :	4 :	5 :	39.9 =	9.37428525

TABLE

For converting Troy Pounds of Water into their equivalent Wine Pints.

Troy Pound	*Wine Pints*	*Troy Pound*	*Wine Pints.*
1. =	0.7900031	6. =	4.7400186
2. =	1.5800062	7. =	5.5300217
3. =	2.3700093	8. =	6.3200248
4. =	3.1600124	9. =	7.1100279
5. =	3.9500155		

TABLE

For converting Troy Pounds into their equivalent Averdupois Pounds.

lbs. Troy	*lbs. Averdups.*	*lbs. Troy*	*lbs. Averdups.*
1. =	0.82285714	6. =	4.93714285
2. =	1.64571428	7. =	5.76000000
3. =	2.46857142	8. =	6.58285714
4. =	3.29142857	9. =	7.40571428
5. =	4.11428571		

TABLE

For converting Averdupois Pounds into their equivalent Troy Pounds.

lbs. Averd.	*lbs. Troy*	*lbs. Averd.*	*lbs. Troy*
1. =	1.215277̇	6. =	7.291666̇
2. =	2.430555̇	7. =	8.506944̇
3. =	3.645833̇	8. =	9.722222̇
4. =	4.861111̇	9. =	10.937500̇
5. =	6.076388̇		

TABLE

For converting Averdupois Ounces into Decimals of the Averdupois Pound.

Oz. Av.	*lbs. Av.*	*Oz. Av.*	*lbs. Av.*
.25 =	.015625	8.00 =	.5000
.50 =	.03125	9.00 =	.5625
1.00 =	.0625	10.00 =	.6250
2.00 =	.1250	11.00 =	.6875
3.00 =	.1875	12.00 =	.7500
4.00 =	.2500	13.00 =	.8125
5.00 =	.3125	14.00 =	.8750
6.00 =	.3750	15.00 =	.9375
7.00 =	.4375		

TABLE

For converting Decimals of the Averdupois Pound into Averdupois Ounces and Decimals.

lbs Av.	*oz. Av.*	*lbs. Av.*	*oz. Av.*
.1 =	1,6	.01 =	.16
.2 =	3.2	.02 =	.32
.3 =	4.8	.03 =	.48
.4 =	6.4	.04 =	.64
.5 =	8.0	.05 =	.80
.6 =	9.6	.06 =	.96
.7 =	11.2	.07 =	1.12
.8 =	12.8	.08 =	1.28
.9 =	14.4	.09 =	1.44

TABLE

For converting Ounces, Drams, and Grains Troy into Decimals of the Troy Pound.

Grain	*lbs. Troy*	*Dram*	*lbs. Troy*	*Oz.*	*lbs. Troy*
1. =	.000173611	1. =	.0104166	1. =	.0833
2. =	.000347222	2. =	.0208333	2. =	.1666
3. =	.000520833	3. =	.0312500	3. =	.2500
4. =	.000694444	4. =	.0416666	4. =	.3333
5. =	.000868055	5. =	.0520833	5. =	.4166
6. =	.001041666	6. =	.0625000	6. =	.5000
7. =	.001215277	7. =	.0729166	7. =	.5833
8. =	.001388888			8. =	.6666
9. =	.001562500			9. =	.7500
				10. =	.8333
				11. =	.9166

TABLE

For converting Decimals of the Troy Pound into Troy Ounces, Drams, and Grains.

lb.	*oz.*	*dr.*	*gr.*	*lb.*	*oz.*	*dr.*	*grs.*	*lbs.*	*grains*
.1 =	1	1	36	.01 =	0	0	57.6	.001 =	5.76
.2 =	2	3	12	.02 =	0	1	55.2	.002 =	11.32
.3 =	3	4	48	.03 =	0	2	52.8	.003 =	17.28
.4 =	4	6	24	.04 =	0	3	50.4	.004 =	23.04
.5 =	6	0	0	.05 =	0	4	48.0	.005 =	28.80
.6 =	7	1	36	.06 =	0	5	45.6	.006 =	34.56
.7 =	8	3	12	.07 =	0	6	43.2	.007 =	40.32
.8 =	9	4	48	.08 =	0	7	40.8	.008 =	46.08
.9 =	10	6	24	.09 =	0	8	38.4	.009 =	51.84

French Weights and Measures.

THE numerous and valuable researches of French authors in every branch of chemistry, require a knowledge in the reader of the weights and measures commonly employed by them; which is more particularly necessary, as the denominations common to several measures in both countries express very different quantities both

absolutely and relatively, which sometimes leads to very serious mistakes. Thus the French *pinte* is equal to nearly two English pints: the *gros* or eighth of an ounce contains 72 grains, whereas our *dram*, which is usually reckoned as its equivalent, contains only 60 grains: the French grain is of less absolute weight than the English grain, but the French inch is longer, and hence the same proportion does not hold in the two countries between the measures of weight and capacity.

The standards of weight and measure were totally changed in France about the year 1794, nearly at the time that similar changes were introduced in the divisions of the year, but though the notation of time has now returned to its ancient course, the system of weights and measures appear still to keep their ground, and are actually adopted in all chemical writings. It is highly necessary, however, to give the old, as well as the new system of mensuration, as the most numerous, and as yet the most important, researches, such as those of Lavoisier, Beaumé, Macquer, &c. were made before the present system was adopted.

We possess very accurate standards of comparison between the French weights and measures and our own, the old French having been carefully compared with the English standards by a commission from the Royal Societies of each country in the year 1752; and the modern French *metre* having been compared with equal accuracy with the English inch by Profr. Pictet in 1801.

The old French weights and measures are the following:

The pound *(poids de marc)* contains 9216 grains, and is divided into 16 ounces, the ounce into 8 gros, and the gros into 72 grains: or as follows:

grains								
24	=	1	denier					
72	=	3	=	1	gros			
576	=	24	=	8	=	1	ounce	
4608	=	192	=	64	=	8	=	1 marc
9216	=	384	=	128	=	16	=	2 = pound

				lb. Troy
The French pound is equal to	7561.	troy grains	=	1.31268
				oz. Troy
The French ounce is =	472.5625	do	=	.984504
				dram
The French gros =	59.0703125	do	=	.984504
The French grain =	0.820421	do		
The Troy pound is equal to	7021.	French grains		
The Averdupois pound =	8538.	do		

In the reduction of the French into English measure, the following Table will assist.

French grains		*Troy grains*
1	=	0.820421
2	=	1.640842
3	=	2.461263
4	=	3.281684
5	=	4.102105
6	=	4.922526
7	=	5.742947
8	=	6.563368
9	=	7.383789
10	=	8.20421
20	=	16.40842
30	=	24.61263
40	=	32.81684
50	=	41.02105
60	=	49.22526
70	=	57.42947
72	=	59.070312

gros		*drams*		*grs.*
1	=	0	:	59.07
2	=	1	:	58.14
3	=	2	:	57.21
4	=	3	:	56.28
5	=	4	:	55.35
6	=	5	:	54.42
7	=	6	:	53.49

French oz.		*Troy oz.*		*drams*		*grs.*
1	=	0	:	7	:	52.56
2	=	1	:	7	:	45.12
3	=	2	:	7	:	37.68
4	=	3	:	7	:	30.24
5	=	4	:	7	:	22.80
6	=	5	:	7	:	15.36
7	=	6	:	7	:	7.92
8	=	7	:	7	:	0.48
9	=	8	:	6	:	53.04
10	=	9	:	6	:	45.60
11	=	10	:	6	:	38.16
12	=	11	:	6	:	30.72
13	=	12	:	6	:	23.28
14	=	13	:	6	:	15.84
15	=	14	:	6	:	8.40

Pounds						
1	=	15	:	6	:	1
2	=	31	:	4	:	2
3	=	47	:	2	:	3
4	=	63	:	0	:	4
5	=	78	:	6	:	5
6	=	94	:	4	:	6
7	=	110	:	2	:	7
8	=	126	:	0	:	8
9	=	141	:	6	:	9

The French toise (which corresponds with our fathom) contains 6 feet, the foot is divided into 12 inches, and the inch into 12 lines.

The French half-toise was found by the authentic measurement of the French academy to be equal to 38.355 English inches; and hence

English foot
The French foot is equal to 12.785 English inches, or to 1.0654167

French foot
The English foot = 11.2632 French inches, or to .9386

The subdivisions of the foot being the same in both countries, their relative proportions are also the same; so that the French inch = 1.0654167 English inches; and the English inch = .9386 French inches.

feet inch lines *Eng. inches*
The old French ell *(Aune)* = 3 : 7 : 10.5 French, = 46.69

French feet		*English inches*
1	=	12.785
2	=	25.570
3	=	38.355
4	=	51.140
5	=	63.925
6	=	76.710
7	=	89.495
8	=	102.280
9	=	115.065
10	=	127.850

Fr. feet or in.		*Eng. feet or in.*
1	=	1.0654+
2	=	2.1308
3	=	3.1962
4	=	4.2616
5	=	5.3270
6	=	6.3925
7	=	7.4579
8	=	8.5233
9	=	9.5887
10	=	10.6541
11	=	11.7195
12	=	12.7850

The French square foot or in. = 1.13510 Eng. square foot or in.
The Eng. square foot or inch = .88126 French sq. foot or in.
The French cubic foot or inch = 1.209367 Eng. cubic foot or in.
The Eng. cubic foot or inch = .8268784 French cubic foot or in.

French cube foot or inch		*Eng. cube foot or inch*
1	=	1.2093+
2	=	2.4187
3	=	3.6281
4	=	4.8374
5	=	6.0468

French cube foot or inch		*Eng. cube foot or inch*
6	=	7.2562
7	=	8.4655
8	=	9.6749
9	=	10.8842
10	=	12.0936

When one French cubic inch weighs 1 grain French, or contains 1 gr. of any other substance, 1 English cubic inch of the same weighs or contains .67839 Eng. grain.

For measures of capacity the old French was (as in this country) different for dry measure and for liquids. The common integer for moderate quantities of liquids was the *Pinte*, which is a little more than a quart English wine measure. The *Chopine* is half the *Pinte*, and the *Poison* is a quarter of the *Chopine*. For larger measures, 8 *Pintes* make a *Septier* or *Velte*, and 36 *Veltes* make a *Muid de Vin* Paris measure, for in the provinces both the divisions and their value were different. There appears also to have been, even in Paris, precisely the same kind of variation in the estimation of the *Pinte* as obtains in this country with the wine pint. The French *Pinte* appears to have been legally equivalent to 48 Fr. cubic inches, and then was exactly $\frac{1}{288}$ of the *Muid*, which was 8 cubic feet. But Beaumé, and probably the other apothecaries of Paris (a body of men abounding in excellent and eminent chemists) make the *Pinte* equal to 32 French ounces of water at the freezing point. The respective valuations of the Pinte will therefore be as follows:

	oz.	*lbs. Troy*	*En. cub. in.*	*Fr. cub. in.*	*En. wine pt.*
The pinte of	32 =	2.62536 =	59.888 =	49.52 =	2.07404

	cub. in.	*Eng. cub. in.*	
The pinte of	48 =	58.0489 =	2.01035
		difference	.06369 =

to about 7 drams, 40 grs. Troy of water.

The difference of nearly an ounce in a quart is sufficiently great to be often felt in the comparison of experiments. The Pinte of 48 Fr. cubic inches appears for another reason to be the legal standard, since it is thus

given in the comparison of the old with the new French weights. The Pinte is there stated to be equal to .9512 of a *Litre*, which is equal to 2.01038 English wine pints.

For dry measure the French used the *Litron*, *Boisseau*, *Minot*, *Mine*, and *Setier de Bled*. The *Litron* is 36 Fr. cubic inches, equal to 1.4652 Eng. wine pint. The *Minot* of 1728 Fr. cub. inch is equal to 1.0099 Winchester bushel of 2110.4 Eng. cub. inch.

The following are the subdivisions of the old French wine and corn measure.

Poison					Litron					
4 =	1 Chopine				4 =	1 Quart				
8 =	2 =	1 Pinte			16 =	4 =	1 Boisseau			
64 =	16 =	8 =	1 Septier or velte		48 =	12 =	3 =	1 Minot		
					96 =	24 =	6 =	2 =	1 Mine	
2304 =	576 =	288 =	36 =	1 Muid de vin	192 =	48 =	12 =	4 =	2 =	1 Setier de Bled

A totally new system of weights and measures has been introduced into the French empire, and is that in which most of the expressions of quantities in chemical experiments are now made. It is therefore necessary in this place to give their corresponding quantities in English measures.

The new French metrical system is founded on a single standard of length which is called the METRE, and is the ten millionth part of the arc of the meridian which extends from the Equator to the Pole, as determined by the actual measurement of a tenth of this arc, between Dunkirk and Barcelona, by several eminent French astronomers. The metre is equal to 36.9413 French inches, which is equal to 39.38272 English inches, the standards of each being at the temperature of melting ice, or 32° Fahr. But

as the standards in this country are always referred to the temperature of 60° or 62° (and the latter is now preferred) the expansion of brass (which is the material of which the standards are made) from 32° to 62° must always be taken into account; for it is obvious that if the English standard is at 62° and the French at 32°, the latter will measure a less quantity of the former than if both were at 32°. The number 39.38272 therefore, which is the equivalent to the French metre when both are at 32°, must be diminished in the proportion in which brass expands 30 degrees, which is estimated by Dr. Young, from Bordas experiments, to make the equivalent to the metre to be 39.371 English inches, the standard of the metre being at 32°, and that of the English inch at 62°.

All the new French measures increase and decrease in decimal proportion, a distinctive prefix being put to the term by which the integer is called. These prefixes are Deca-, Hecto-, Kilo-, and Myria-, (taken from the Greek numerals) to express the *multiplication* of the integer by 10, 100, 1000, and 10000 respectively; and Deci-, Centi-, and Milli-, (from the Latin numerals) to express the *division* of the integer by 10, 100, or 1000. Or according to the following scale, taking the metre as the integer.

	Metres		*Metres*
1 Myriametre =	10000	1 Metre =	1.
1 Kilometre =	1000	1 Decimetre =	0.1
1 Hectometre =	100	1 Centimetre =	0.01
1 Decametre =	10	1 Millimetre =	0.001

The metre is the integer of the measure of length, and from it all the measures of surface, capacity, and weight, are deduced in the following way.

For square dimensions the metre or its parts squared are employed. When used for measuring land the term

Are is adopted, which is a decametre squared. A *Hectare*, or 100 *Ares*, are about equivalent to 2 English acres.

For the integer of the measure of capacity, both wet and dry, the decimetre cubed is employed, and is called the *Litre*. It is more than a third larger than the old French Litron, and is equal to $2\frac{1}{8}$ English wine pints.

The cubic metre is also called a *Stere*, but is only used for measuring fire wood, to be substituted for the old French *Corde de Bois*.

For the integer of the measure of weight, the weight of a cubic centimetre of distilled water at 32° has been adopted. This is called a *Gramme*, and is equivalent to abont $15\frac{1}{2}$ English grains.

Of these measures the *Metre*, *Litre*, and *Gramme*, are almost the only integers that the chemical reader will ever meet with, and certainly their uniformity and exact ratio to each other, and decimal progression, render the comparison of them with our own measures extremely easy.

The following are the correspondences between these and English measures.

The Metre = 39.371 English inches.
The square Metre = 1550.075641 English square inches.
The square Decimetre = 15.50075 English square inches.

cube feet *cube in.*

The Cubic Metre = 61028.028 Eng. cubic inches = 35 : 548.028
The Cubic Decimetre the same as the Litre.

English cubic inches

The Litre, equal to the bulk of Kilogramme of water = 61.028

Troy grains

The Gramme, or weight of a cubic centimetre of water = 15.44402

The following Tables will assist the Reader.

Metre		*Eng. feet.*		*Inches*
1	=	3	:	3.371
2	=	6	:	6.742
3	=	9	:	10.113
4	=	13	:	1.484
5	=	16	:	4.855
6	=	19	:	8.226
7	=	22	:	11.597
8	=	26	:	2.968
9	=	29	:	6.339

Decimetre		*Eng. Inches*
1	=	3.9371
2	=	7.8742
3	=	11.8113
4	=	15.7484
5	=	19.6855
6	=	23.6226
7	=	27.5597
8	=	31.4968
9	=	35.4339

Litre		*Eng. cub. inch*		*Ale pints*		*Wine pints*		*Oz. Troy of water*
1	=	61.028	=	1.7313	=	2.11353	=	32.104
2	=	122.056	=	3.4626	=	4.22706	=	64.208
3	=	183.084	=	5.1939	=	6.34059	=	96.312
4	=	244.112	=	6.9252	=	8.45412	=	128.416
5	=	305.140	=	8.6565	=	10.56765	=	160.520
6	=	366.168	=	10.3878	=	12.68118	=	192.624
7	=	427.196	=	12.1191	=	14.79471	=	224.728
8	=	488.224	=	13.8504	=	16.90824	=	256.832
9	=	549.252	=	15.5817	=	19.02177	=	288.936

Gramme.		*Troy grs.*
1	=	15.444
2	=	30.888
3	=	46.332
4	=	61.776
5	=	77.220
6	=	92.664
7	=	108.108
8	=	123.552
9	=	138.996

Deca-gramme		*Troy dram*		*grs.*
1	=	2	:	34.44
2	=	5	:	8.88
3	=	7	:	43.32
4	=	10	:	17.76
5	=	12	:	52.20
6	=	15	:	26.64
7	=	18	:	1.08
8	=	20	:	35.52
9	=	23	:	9.96

Hecto-gramme		*Troy oz.*		*Averd. oz.*
1	=	3.2175	=	3.5279
2	=	6.4350	=	7.0558
3	=	9.6525	=	10.5837
4	=	12.8700	=	14.1116
5	=	16.0875	=	17.6395
6	=	19.3050	=	21.1674
7	=	22.5295	=	24.6953
8	=	25.7400	=	28.2232
9	=	28.9575	=	31.7511

The decimal progression of all the French weights and measures renders it only necessary to change the decimal point in order to convert one into the equivalent of any other, of the same species and numerically the same, but of a different denomination. Thus as 9 litres are equal to 15.5817 ale pints, 9 hectolitres will be equal to 1558.17 ale pints; and so of the rest.

German Weights and Measures.

A VAST variety of weights and measures are in local use in Germany, as slight differences exist between the *mark*, *ell*, &c. of almost every state. There appears, however, from the accurate account given by Gren (in his System. Handbuch der Chemie, Vol. I.) to be two kinds of weight, to which all those employed in Germany may be referred, and which are sufficient for our present purpose.

The ancient and most authentic standard of weight is the

Cologne mark, or *Mark of Charlemagne*, with its divisions. The mark is the highest integer used in this standard which was intended for gold and silver, but it is also considered as half the Cologne pound. The *mark* contains 8 ounces, the *ounce* 2 loths, the *loth* 4 quentchens or drams, and the *quentchen* 1 pfenning, pennyweight, or denier. Besides this, the *pfenning* is subdivided into 256 *Recht-pfenning theil*, or standard parts, which last division, however, is only hypothetical, but is extremely useful for comparison; for as the pfenning is itself the 256th part of the mark, the latter contains 65536 standard parts, which is a sufficiently minute division for all actual calculations. The Cologne Mark therefore is thus divided:

Standard parts													
256	=	1	Pfenning										
1024	=	4	=	1	Quentchen								
4096	=	16	=	4	=	1	Loth						
8192	=	32	=	8	=	2	=	1	Ounce				
65536	=	256	=	64	=	16	=	8	=	1	Mark		

Also two marks make a pound. The Pfenning is further subdivided either into 2 *Heller*, or into 17 *Eschen*, or into 9 *As*.

The *Grain* weight therefore does not enter into this division of the Cologne Mark, but in the division for weighing gold and silver it is used, as will be mentioned.

The other set of weights used commonly in Germany is the *Nuremburg Medicinal Weight*, the integer or pound of which is divided precisely the same as the apothecaries' division of the English pound Troy; that is to say, the pound into 12 ounces, the ounce into 8 drams, the dram into 3 scruples, and the scruple into 20 grains. Neither the pound nor ounce nor dram of the Nuremburg weight are the same as the pound, ounce, and quentchen of the Cologne weight, the Nuremburg pound being = 100423.5 standard parts — and the ounce = 8368.625 St. Pts. For commerce and common use the Nuremburg pound is increased to 16 ounces = 133898 St. Pts.

The Nuremburg medicinal pound of 12 ounces appears to be the standard for apothecaries' weight all over Germany, and therefore is probably that which is more commonly used by chemists. Hence, when we meet with the term pound, ounce, dram, and grains, in German chemical authors, we may generally conclude that it is the Nuremburg medicinal weight, unless otherwise specified.

But the Cologne Mark weight is employed universally for assaying gold and silver, and therefore is also of very frequent occurrence.

The English Troy pound is given by Gren as equal to 104688 St. Pts. of the Cologne Mark, whence the Nuremburg pound, ounce, dram, scruple or grain = .959266 English Troy pound, ounce, dram, &c. respectively: or by the following Table.

Nuremburg		*Eng. Troy*	*Nuremburg*		*Eng. Troy*
1	=	0.95926	6	=	5.75560
2	=	1.91853	7	=	6.71486
3	=	2.83780	8	=	7.67418
4	=	3.83706	9	=	8.63339
5	=	4.79633			

The Cologne ounce is = 8192 standard pts. and the Troy ounce is = 8724 st. pts. whence the Cologne ounce, and eighth of an ounce (or quentchen) is = .939018 Troy ounce or dram respectively: and the Cologne mark is = 7.512144 Troy ounces: or by the following table:

Cologne oz. or Quentchen.		*Troy oz. or dr.*	*Cologne oz or Quentchen.*		*Troy oz. or dr.*
1	=	.939	6	=	5.634
2	=	1.878	7	=	6.573
3	=	2 817	8	=	7.512
4	=	3.756	9	=	8.451
5	=	4.695			

When gold and silver are weighed in Germany by the Cologne mark, it has a totally different subdivision from the common ounce, quentchen, and pfenning.

For gold, the mark is divided into 24 carats, and the carats into 12 grains. The *Carat* therefore, where it is a real weight, is equal to 150.242 Troy grains, and the *Grain*, or 288th part of the mark, is equal to 12.52 Troy grains.

For silver, the mark is divided, as usual, into 16 *Loths*, or half ounces, but the loth into 18 *Grains*. The grain is in this case also the 288th part of the mark. This circumstance of employing the term *grain* occasionally for a subdivision of the mark, and giving to it a value upwards of 13 times the Nuremburg grain, should be carefully noted, as many errors may arise from it, particularly to the English reader.

The method of conducting the assay of gold and silver has been described under the article of Assay, and it is there mentioned (p. 117)* that the small piece of gold cut off the ingot to be assayed is called an *Assay mark*, and (like the real mark of gold) is divided into 24 carats, and each carat into 12 grains, by small sets of weights used for this purpose. The actual quantity of gold used for this purpose is half a pfenning, or $\frac{1}{512}$ of a

* Of Aikin's Dictionary.

real mark = 128 standard parts, or about 7 grains Troy. The assay grain is further divided into halves and quarters. The *Assay mark for Silver* is divided as the real mark for this metal, namely, into 16 loths, and each loth into 18 grains, and the grain into halves and quarters; and the real weight of the silver assay mark is twice that of gold, or one pfenning.

The German assayers and mineralogists have also the *Docimastic Centner*, which has generally the actual weight of one quentchen (equal to 56.34 grains Troy) but is subdivided into 100 docimastic pounds, each of which therefore is equivalent to about ½ grain Troy.

The most common measure of length in Germany is the *Rhinland foot*, to which standard the foot, ell, &c. of the different states is usually compared.

With regard to the length of this measure in English inches, the *Pied du Rhin* is said in Peuchet's Dict. de Commerce, to be = 11 inch. : 7 lines, of the old French *Pied de Roi*, which is = 12.341 English inches. Hence we have the following numbers, viz. 1 Rhinland foot = 12.341 English inches, and therefore 1 Rhinland inch = 1.02842 English inches, and 1 cubic inch Rhinland = 1.08769 English cubic inches, = 274.648 Troy grains of distilled water = 286.31 Nuremb. grains.

On the other hand, Klaproth, in his analysis of the Carlsbad water, and in the other parts of his works, employs the cubic inch, which, he says, holds 290 of the true Nuremburg grains of distilled water, and which appears to be as common a standard of length among the German chemists as the Nuremburg is of weight. Now according to Gren, 290 Nuremb. grains, = 278.187 Troy grains, = 1.10169 English cubic inch. of water, and the cube root of 1.101700+ (which hardly differs from

1.101693) is = 1.032812. So that the inch used by Klaproth is probably the Rhinland inch, which by this estimation is = 1.032812 English inches, and by the is = 1.02842 English inches, the difference being only about .0044.

We may therefore without danger of material error, consider the inch used by most of the German chemists (unless otherwise specified) as that which, when cubed, contains 290 Nuremburg grains of water, and as having the following proportions with the English.

Germ. feet or in.		*Eng. feet or in.*	*Germ. cub. in.*		*Eng. cub. in.*
1	=	1.0328	1	=	1.1017
2	=	2.0656	2	=	2.2034
3	=	3.0984	3	=	3.3051
4	=	4.1312	4	=	4.4068
5	=	5.1640	5	=	5.5085
6	=	6.1969	6	=	6.6102
7	=	7.2297	7	=	7.7119
8	=	8.2625	8	=	8.8136
9	=	9.2953	9	=	9.9153

When 1 German cubic inch weighs or contains 1 Nuremburg grain; 1 cubic inch English weighs or contains .8707 Troy grain.

No. 3.

Report made by the Physical and Mathematical Class of the Institute in Answer to the Question, whether those Manufactories, from which a disagreeable Smell arises, may prove injurious to Health. Read in the Sitting of January, 1805, by Messrs. GUYTON-MORVEAU and CHAPTAL.*

THE minister of the home department has consulted the class on a question, the solution of which is of essential import to our manufacturers.

* Phil. Jour. Vol. 12. p. 122. from An. de Chim. Vol. 54.

The object is to determine, whether the vicinity of certain manufactories can be injurious to health.

The solution of this problem must appear of the more consequence, as, from the confidence which the decisions of the Institute naturally merit, it may hereafter form the basis of decisions in a court of justice, when sentence is to be pronounced between the fate of a manufactory and the health of our fellow-citizens.

The solution is so much the more important, it is become so much the more necessary, as the fate of the most useful establishments, I will say more, the existence of many arts, has depended hitherto on simple regulations of police; and that some, driven to a distance from materials, from workmen, or from consumers, by prejudice, ignorance, or jealousy, continue to maintain a disadvantageous struggle against innumerable obstacles, by which their growth is opposed.

Thus we have seen manufactories of acids, of sal ammoniac, of Prussian blue, of beer, and of leather, successively banished from cities; and we daily see appeals to authority against these establishments made by troublesome neighbours or jealous rivals.

As long as the fate of these manufactories is insecure, as long as an arbitrary legislation possesses a right to interrupt, suspend, or fetter the hands of a manufacture; in a word, as long as a simple magistrate of police has at his nod the fortune or ruin of a manufacturer, how can we conceive, that he will be so imprudent as to engage in undertakings of such a nature? How could it be expected, that manufacturing industry should establish itself on such a frail basis? This state of uncertainty, this continual contest between the manufacturer and his neighbours, this perpetual doubt respecting the fate of an establishment, paralize and confine the efforts

of the manufacturer, and gradually extinguish both his courage and his powers.

It is an object of primary necessity therefore to the prosperity of the arts, that lines should be drawn, so as no longer to leave any thing at the arbitrary will of the magistrate; to point out to the manufacturer the circle in which he may exert his industry with freedom and security, and to assure the neighbouring proprietor that he has nothing to fear for his health, or for the produce of his fields.

To arrive at the solution of this important problem, it appeared to us indispensable, that we should take a view of each of the arts, against which the most clamour has been raised.

With this view we shall divide them into two classes. The first will comprise all those, the processes of which allow aeriform emanations to escape from them into the atmosphere, either in consequence of putrefaction or fermentation, which may be deemed nuisances from their smell, or dangerous from their effects.

The second class will include all those, in which the artist, operating by the aid of fire, developes and evolves in air or vapour various principles, which are more or less disagreeable to respire, and reputed more or less injurious to health.

In the first class we may advert to the steeping of flax and hemp, the making of catgut, slaughter-houses, starch-manufactories, tanneries, breweries, &c.

In the second, the distillation of acids, of spirits, and of animal substances; gilding on metals, preparations of lead, copper, and mercury, &c.

The arts of the first class, considered in relation to the health of the public, merit particular attention, because the emanations that proceed from fermentation or putrefaction are really injurious to health in some cases,

and under certain circumstances: the steeping of flax and hemp, for instance, which is performed in ponds or still waters, infects the air and kills fishes; and the diseases to which it gives rise are all known and described: Accordingly wise regulations have almost every where enjoined, that this operation should be carried on without the precincts of towns, at a certain distance from every dwelling, and in waters, the fish of which constitute no resource for the public. These regulations unquestionably ought to be continued; but as the execution of them is attended with some inconvenience, it is to be wished, that the process of Mr. Brale, the superiority of which has been confirmed by Messrs. Mongez, Berthollet, Tessier, and Molard, should soon become known and adopted.

Other operations on vegetables, or certain products of vegetation, to obtain fermented liquors, as in breweries; to extract colours, as in the manufactures of litmus, archil, and indigo; or to divest them of some of their principles, as in manufactories of starch, paper, &c. do not appear to us of such a nature as to be capable of exciting any disquietude in the mind of the magistrate. At all events, the emanations arising from these substances in a state of fermentation can prove dangerous only near the vessels and apparatus in which they are confined, ceasing to be so the moment they are mingled with the open air; so that a little prudence only is required, to avoid all danger from them. Besides, the danger affects only the manufacturers themselves, and by no means the inhabitants of the neighbouring houses, so that a regulation enjoining these manufactories to be removed out of towns, and to a distance from any dwelling-house, would be an act of authority both unjust, vexatious, and injurious to the progress of manufactures, and in no respect a remedy for the evils attending the operation.

Some preparations extracted from animal substances require the putrefaction of these substances, as in the fabrication of catgut; but it is more frequently the case, that animal substances employed in manufactures are liable to putrefaction from being kept too long, or exposed to too great warmth, as we particularly find in dyeing cotton red, a process in which a large quantity of blood is employed. The miasmata exhaled by these putrid matters spread far round, and form a very disagreeable atmosphere for all the neighbourhood to breathe; it is the part of a good government, therefore, to cause these substances to be renewed so as to prevent putrefaction, and the manufactory to be kept so far clean, that no refuse of the animal substances employed shall be left to rot in them.

In this last point of view slaughter-houses exhibit some inconveniencies; but they are not of sufficient importance to require them to be placed without the precincts of towns, and assembled together in one spot, as speculative men are daily proposing to government. A little attention on the part of the magistrate, to prevent butchers from throwing out the blood and refuse of the beasts they kill, would be sufficient to remedy completely every thing disgusting or unhealthy arising from slaughter-houses.

The fabrication of *poudrette* (night-soil dried) begins to be established in all the large towns of France, and the operation by which excrementitious substances are reduced to this state, necessarily occasions a very disagreeable smell for a long time. Establishments of this kind therefore ought to be confined to airy places, remote from any habitation; not that we consider the aeriform exhalations from them as injurious to health; but no one can deny, that they are incommoding, noisome, disagreeable, and difficult to breathe, on all which accounts they

ought to be removed to a distance from the dwellings of men.

There is a very important observation to be made on the spontaneous decomposition of animal substances, which is, that the emanations from them appear to be so much the less dangerous, as the substances which undergo putrefaction are less humid: in the latter case, a considerable quantity of carbonate of ammonia is evolved, which imparts its predominant character to the other matters volatilised, and corrects the bad effects of such as are deleterious. Thus the decomposition of stercoraceous matters in the open air, and in places the situation and declivity of which allow the fluids to drain off, and that of the refuse of the cocoons of the silk-worm evolve a vast quantity of carbonate of ammonia, which corrects the virus of some other emanations; while the very same substances, decomposed in water or drenched with this fluid, exhale sweetish and nauseous miasmata, the respiration of which is very dangerous.

The numerous arts in which the manufacturer produces and diffuses in the air, in consequence of his processes and by the help of fire, vapours more or less disagreeable to breathe, constitute the second class of those we have to examine.

These, more interesting than the former, and much more intimately connected with the prosperity of our national industry, are still oftener the subject of complaints brought before the magistrate for decision, and on this account have appeared to us to require more particular attention.

We will begin our examination with the manufacture of acids.

The acids that may excite complaints of the neighbours against their preparation are the sulphuric, nitric, muriatic, and acetous.

The sulphuric acid is obtained by the combustion of a mixture of sulphur and nitre. It is very difficult in this process to prevent a more or less observable smell of sulphurous acid from being diffused around the apparatus, in which the combustion is performed; but in manufactories skilfully conducted this smell is scarcely perceptible within the building itself, is not dangerous to the workmen who respire it daily, and can give no reasonable foundation for complaint to the neighbours. When the art of making sulphuric acid was introduced into France, the public opinion was strongly expressed against the first establishments for the purpose; the smell of the match with which we kindle our fires contributed not a little to exaggerate the effect that must be produced by the rapid combustion of several hundred weight of brimstone; but men's fears on this head are now so much allayed, that we see several of these manufactories prosper in peace in the midst of our cities.

The distillation of aqua fortis and spirit of salt, in other words, of the nitric and muriatic acids, are not more dangerous than that of sulphuric acid. The whole of the process is performed in an apparatus of glass or earthen-ware, and it is unquestionably the great interest of the manufacturer to diminish the volatilization or loss of the acid as much as possible. Yet, let him pay whatever attention he will to this, the air breathed in the manufactory is always impregnated with the smell peculiar to each of these acids; but you may respire there freely and safely, the men who work in it daily are not at all incommoded by it, and the neighbours would be very much in the wrong to complain.

Since the manufactories of white lead, of verdigris, and of sugar of lead, have increased in France, the demand for vinegar has been enlarged.

When this acid is distilled, to fit it for some of the

purposes for which it is used, it diffuses to a distance a very strong smell of vinegar, in which there is no danger; but when a solution of lead in this acid is evaporated, the vapours assume a sweetish character, and produce in those who respire them constantly, all the effects peculiar to the emanations of lead itself. Happily these effects are confined to the people who work in the manufactory, and are unfelt by those who dwell in the vicinity.

The preparations of mercury and of lead, those of copper, antimony, and arsenic, and the processes of gilding on metals, are none of them without some danger to the persons who reside in those manufactories, and are concerned in the operations; but their effects are bounded by the walls within which they are carried on, and are dangerous only to the persons concerned in the manufactories. It is an object well worthy the attention of chemists, to investigate the means of preventing these injurious effects, and indeed many of the inconveniencies have already been prevented by the help of chimneys, which convey the vapours into the air out of the reach of respiration; and at the present the whole attention of administration ought to be confined to directing science toward the means of improvement of which these processes are susceptible with regard to health.

The fabrication of Prussian blue, and the extraction of carbonate of ammonia by the distillation of animal substances in the new manufactories of sal ammoniac, produce a large quantity of fetid vapours or exhalations. These exhalations, it is true, are not injurious to health; but as it is not sufficient to constitute a good neighbour, not to be a dangerous one merely, but not even to be a disagreeable one, they who undertake such manufactures, when they have to seek a situation for them, should prefer one remote from any dwelling-house. But when

such a manufactory is already established, we would be far from advising the magistrate to order its removal: it would be sufficient in such cases, to oblige the manufacturer to build very high chimneys, that the disagreeable vapours produced in these operations may be dissipated in the air. This is particularly practicable for the fabrication of Prussian blue, and by adopting it one of our number has continued to retain in the midst of Paris one of the most important manufactories of this kind we have, against which the neighbours had already leagued.

In the report we lay before the class we have thought it our duty to attend only to the principal manufactories, against which violent clamours have been raised at divers times and places. It is easy to see, from what has been said, that there are but few the vicinity of which is injurious to health.

Hence we cannot too strongly exhort those magistrates who have the health and safety of the public committed to their charge, to disregard the unfounded complaints, which, too frequently brought against different establishments, daily threaten the prosperity of the honest manufacturer, check the progress of industry, and endanger the fate of art itself.

The magistrate ought to be on his guard against the proceedings of a restless or jealous neighbour; he should carefully distinguish what is only disagreeable or inconvenient from what is dangerous or injurious; he should recollect that the use of pit-coal was long proscribed, under the frivolous pretence that it was injurious to health; in short, he should be fully aware of this truth, that, by listening to complaints of this nature, not only would the establishment of several useful arts in France be prevented, but we should insensibly drive out of our cities the farriers, carpenters, joiners, braziers, coopers, founders, weavers, and all whose occupation is more or less

disagreeable to their neighbours. For certainly the employments just named are more unpleasant to live near than the manufactories mentioned above, and the only advantage they enjoy is that of ancient practice. This right of toleration has been established by time and necessity; let us not doubt therefore, but our manufactures, when grown older and better known, will peaceably enjoy the same advantage in society; in the mean time we are of opinion, that the class ought to avail itself of this circumstance, to put them in a particular manner under the protection of government, and declare publicly, that the manufactures of acids, sal ammoniac, Prussian blue, sugar of lead, white lead, starch, beer, and leather, as well as slaughter-houses, are not injurious to the health of the vicinity, when they are properly conducted.

We cannot say as much for the steeping of hemp, making catgut, laystalls, and in general establishments where a large quantity of animal or vegetable matter is subjected to humid putrefaction. In all these cases, beside the disagreeable smell they exhale, miasmata, more or less deleterious, are evolved.

We must add, that, though the manufactories of which we have already spoken, and which we have considered as not injurious to the health of the neighbourhood, ought not to be removed, yet administration should be requested to watch over them strictly, and consult with well-informed persons for prescribing to the conductors the most proper measures for preventing their smoke and smell from being diffused in the vicinity. This end may be attained by improving the processes of the manufactures, raising the outer walls, so that the vapours may not be diffused among the neighbours; improving the management of the fires, which may be done to such a point, that all the smoke shall be burnt in the fire-place, or deposited in the tunnels of long chimneys; and main-

taining the utmost cleanliness in the manufactories, so that nothing shall be left to putrify in them, and all the refuse capable of fermentation be lost in deep wells, and prevented from any way incommoding the neighbours.

We shall observe too, that when new manufactories of Prussian blue, sal ammoniac, leather, starch, or any other article by which vapours very inconvenient to the neighbours, or danger of fire or explosions are to be established, it would be wise, just, and prudent, to lay down as a principle, that they are not to be admitted into cities, or near dwellings, without special authority; and that, if persons neglect to comply with this indispensable condition, their manufactories may be ordered to be removed without any indemnification.

It follows from our report, 1st, that catgut manufactories, laystalls, steeping of hemp, and every establishment in which animal or vegetable matters are heaped together to putrify in large quantities, are injurious to health, and ought to be remote from towns and every dwelling house: 2dly, that manufactories where disagreeable smells are occasioned through the action of fire, as in the making of acids, Prussian blue, and sal ammoniac, are dangerous to the neighbours only from want of due precautions, and that the care of government should extend only to an active and enlightened superintendance, having for its objects the improvement of their processes and of the management of the fire, and the maintenance of cleanliness: 3dly, that it would be worthy a good and wise government, to make regulations prohibiting the future establishment of any manufacture, the vicinity of which is attended with any essential inconvenience or danger, in towns or near dwelling-houses, without special authority previously obtained. In this class may be comprised the manufactories of poudrette, leather, and starch; foundries, melting houses for tal-

Manufacture of Gun flints.

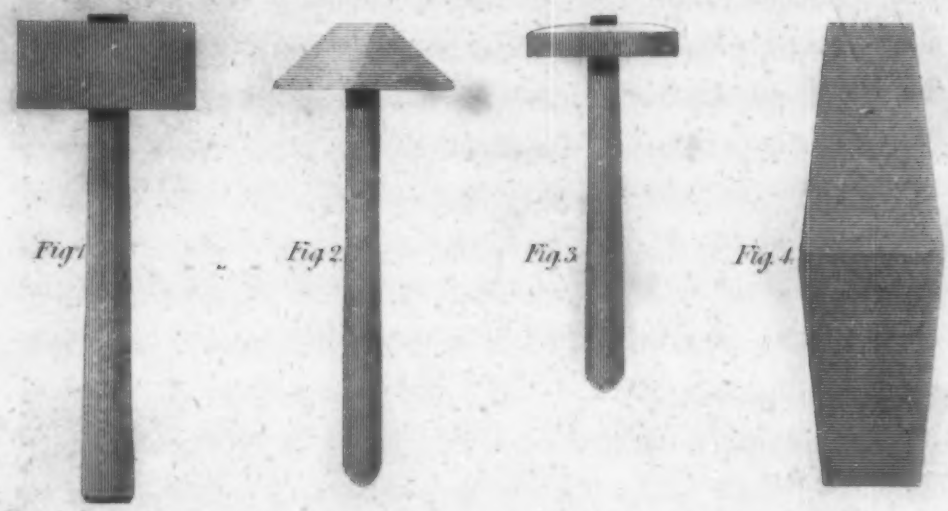


Fig 1. Fig 2. Fig 3. Fig 4.

Fig 5.

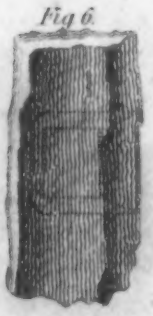


Fig 6.

Fig 7.

P. Tiebout.

Emporium of Arts & Sciences Vol. I. Pl. I.

low, slaughter-houses, rag warehouses, manufactories of Prussian blue, varnish, glue, and sal ammoniac, potteries, &c.

Such are the conclusions which we have the honour to lay before the class, and addressed to government, with invitation to make it the base of its decisions.

No. 4.

A Memoir on the Art of making Gun-Flints.

By CITIZEN DOLOMIEU.*

With an Engraving.

THE art of making gun-flints, which has been long practised in a small territory situated between the two neighbouring departments of Loir-Cher and L'Indre, is directed to an object, of which the whole value, commercially considered, is of little magnitude; but which is of the first necessity in the use of fire-arms of every description. The author of the present Memoir was desirous of acquiring some information respecting it, but found that it was to no purpose that he extended his researches to a variety of works on mineralogy and different subjects of the arts and trade. The Encyclopédie is silent on this process; excepting in the repetition of a ridiculous prejudice concerning the re-production of flints in places whence they were excavated. From the precision with which the figure is given to these stones, it

* Nich. Phil. Jour. vol. 1. p. 88. from Mem. de l'Institute Nationale, 3. 348.

NOTE. Whether the true gun-flint has been found in America I do not at present recollect; there can however be little doubt that it exists among us; it is of too great national importance to depend for our supplies from foreign sources, of an article of such prime necessity, and it may be hoped that the present communication will lead to a due investigation of the subject. Dr. Seybert states in the Philadelphia Medical Museum, Vol. 5. p. 157. that "large masses of common flint are found near Easton, Northampton county, and near Reading, Berks county, Pennsylvania," and appropriates to it the name by which the author of the present essay describes the true gun-flint. ED.

has even been suspected that they could hardly be afforded at the low price they bear, if in its first state the material were not even soft. But the art is extremely simple in its process; it requires a very small number of instruments, a short apprenticeship, and a very moderate degree of skill to form, by mere fracture, figures so accurate, faces so smooth, outlines so direct, and angles so neat, that the stone seems as if cut on the wheel of the lapidary. Five or six small blows of the hammer, during one minute of time, are sufficient to produce the same perfection of figure as would require more than an hour's labour, if the sections were to be made by grinding against harder substances, or friction with emery. Less than a farthing will pay for a gun-flint from the hand of the workman, but fifty times that sum would be insufficient for its purchase if it were fashioned by any other process.

The author regularly proceeds to examine first the material best adapted to the use in question, the instruments employed, and the manipulation by which the stones are fashioned.

With regard to the material, every kind of stone, capable of producing strong sparks when struck against steel, may be used as a gun-flint, if it can but be fashioned by simple and cheap means. But even in this case there are some motives of preference; such, for example, as that the scintillation should be produced with the least possible blow, and with no considerable wear or abrasion of the steel. These reasons of predilection are in favour of the siliceous stones, when compared with those which are called quartzose. But the silex or flint, properly so called, possesses not only this kind of superiority, but another property, that it is more particularly susceptible of being broken into fragments or plates, which require but very little labour to give them the requisite form and dimensions.

Among the silex it is therefore that the fabricators of gun-flints have found the material truly proper for the exercise of the art. And among the numerous varieties of this species of stone, there is only one which can be advantageously fashioned by the hammer alone. The agates and chalcedonies, which are also applied to this use, are brought to the requisite form by the mill of the lapidary. The makers of gun-flints in France denominate the stone of which they make use *caillou*, and they themselves are called *caillouteurs*. The word *caillou* is used by them to denote the best and most serviceable kind of flint; whereas, in the other parts of France, it denotes a pebble; that is to say, a rounded stone, whatever may be its nature.

The flint of the workmen in gun-flints belongs to that species of silex which naturalists have denominated silex gregarius, silex ignarius, or the feuerstein of the Germans, &c. But every coarse flint is not proper for this use. In fact, the best stone is far from being plentiful in nature. Many countries are entirely deprived of them; and the author thinks that it may probably be affirmed, that France almost alone possesses that variety of silex which can be easily broken into gun-flints, since he cannot suppose that the art of making them could remain a mystery to other nations who do not practice it, though they make great use of the flints: the art itself being so simple, that they must have speedily acquired it, if they have possessed the material.

In his description of the variety of silex here alluded to, he gives it the name of silex pyromachus, to express its use, which he prefers to the term silex sclopetarius, as being more musical.

The external characters are:

The silex pyromachus, when dug up, is always covered with a white external crust, one or two lines or more

in thickness, of an earthy, chalky appearance, and loose texture, much softer and less heavy than the silex it envelopes. The external form of the masses of good stones of this description has a somewhat convex surface, approaching to the globular figure. Those of irregular forms are full of imperfections. The best stones are not very large. They seldom exceed the weight of twenty pounds, and they ought not to be of less weight than one or two pounds. Their aspect, when broken, is greasy, shining a little, and the grain is so fine, that it is imperceptible. The colour of these good stones may vary from the yellow colour of honey to a blackish brown. In this respect it is to be noted that the value of a stone does not depend on its colour, but on the uniformity of the tint, which becomes less intense when the stone is reduced into thin splinters. The flints of the two departments first mentioned are yellowish. Those of the chalk hills on the banks of the Seine are blackish brown. Both the one and the other, when pulverised, are perfectly white. The silex pyromachus ought to possess an uniform semi-transparence, of a greasy aspect, to such a degree, as to admit letters to be distinguished through a piece of the stone of one-fiftieth of an inch thick, laid close upon the paper. Its fracture must be smooth and equal throughout, and very slightly conchoidal; that is to say, convex or concave. This kind of fracture is one of the most essential properties upon which the faculty of being divided into gun-flints depends.

The workmen select the stones proper for their use by their external character. They compare that part of the masses of silex, which is uniformly semi-transparent and coloured, to the inner skin of bacon, which they call *couenne*. They say that one flint has more or less *couenne*, or is more or less fat than another. They assert

that the upper part of a flint is always of a better quality than the lower. Flints are considered as imperfect or intractable when naturally deprived of any of the external characters before indicated, or when injured by long exposure to the air. Most of the masses are subject to have whitish opaque spots and a kind of knots where the material is harder than in the other part of the stone. When these accidents are too abundant, the stone is rejected as useless.

The physical characters are as follow :—Specific gravity of the white silex pyromachus from the banks of the Cher proved to be 26041 ; that of the blackish kind from the chalk isles of Laroche Guion was 25954. In this respect it does not differ essentially from the other varieties of silex, of which the specific gravities are usually between 26100 and 25900. Hardness a little superior to that of jasper, but inferior to that of agate and chalcedony. It is nearly the same as that of the other common flints. Brittleness. It is more brittle than most other siliceous stones. The light coloured is more so than the darker ; these last being rather more scintillant, and wear away the hammer more quickly. When two pieces of the silex pyromachus are strongly rubbed together, they emit the peculiar well known smell of siliceous stones, but in this variety it is more strong than in any other.

Chemical characters. Action of the air.

The silex pyromachus, deprived of its natural coating, and exposed for a long time to the changes of the atmosphere, acquires a second white friable coating, consisting of the silex reduced to powder ; and even its internal part loses its greasy appearance and semi-transparency, so as to become whitish. In this case the specific gravity, which was 25954, becomes 25754, consequently it has lost 200 parts of the weight it possessed at first.

The silex pyromachus is sometimes too moist when taken out of the quarry. It requires to be dried; but if by too long exposure to the air or the wind it loses a certain portion of humidity which is often very perceptible when it is recent, it can then no longer be broken into gun-flints, as its fracture is less easy. The workmen carefully reject all those which have lost this favourable degree of moisture. Perhaps they might be restored by keeping them in a damp place, or covering them with earth, and by these means at least they might succeed in preserving those intended to be worked up in winter.

When the fragments are thrown upon a red hot plate of iron, it flies and cracks, and becomes opaque. When projected in powder upon nitre in fusion, it gives a few sparks with slight inflammation and detonation.

When calcined in a test, it loses one 250th part of its weight, increases in bulk, becomes extremely white, and so brittle as to be almost friable. In this state it resembles the finest porcelain biscuit.

When distilled in a retort by strong heat, it affords a little carbonic acid gas, and a quantity of water amounting to 200 parts of the weight before indicated as its specific gravity; but gives no sign of the combustible matter which in the preceding experiment caused the nitre to detonate.

This water, which appears essential to all the flints, and may be called their radical water, is the cause of their transparency. Exposure to air by drying them, renders them opaque; so that they may be considered as imperfect hydrophanes; for they do not again absorb, but with difficulty the water necessary to their transparence. This water also contributes to the connexion of their integrant particles, whence their fracture becomes more equal, and is harsh when they have lost it. These flints when recently dug up even afford an aqueous vapour

when struck, and the face of the fracture is humid, and as it were moist.

Chemical analysis.

Citizen Vanquelin examined 100 parts of silex pyromachus of a brownish colour, and uniformly semi-transparent from the hills of La Roche Guion. He mixed the mass with 400 grains of very pure potash, which by fusion in a silver crucible afforded a compound, which after cooling was diffused in water, and then super-saturated with muriatic acid. The very clear solution was evaporated to dryness, re-dissolved in water, and the silex thus saturated, and left upon the filter after being well washed, dried and ignited, weighed 97 grains. Ammonia was afterwards added to the clear liquid, where it produced a slight yellowish white precipitate, which after being well washed and dried weighed one grain, and was found to be a mixture of alumine and oxide of iron. The fluid separated from this small portion of iron and alumine, gave no other precipitate on the addition of carbonate of potash, and the waters used in the washing left no residue when they were evaporated to dryness. The result therefore was silex = 97 grains, alumine and oxide of iron = 1, loss = 2, The author considers it to be a very remarkable fact, that the silex pyromachus should contain only silex and water, the alumine and iron being too small in quantity to be considered as essential to its composition, or to influence its habitudes. Quartz also, from the analyses which have been made, appears to contain only silex; yet the more he examines the two substances, the more he finds reason to suppose them essentially different from each other; since the one refuses to assume the crystalline form, and the other assumes it and becomes clear, even in contact with the flint itself. The one appears to be incapable of admitting water into its composition, while the other constantly contains it until it

begins to be decomposed. He offers a query, whether the difference may not consist in the small portion of combustible or fatty matter, which caused the detonation with nitre, or whether the quartz may not, like alum, acquire its property of crystallizing from the addition of some other substance. This question, as he remarks, must be resolved by future experimental enquiries.

The analysis of the whitish spots afforded silex 98 grains, oxide of iron 1, carbonate of lime 2. That of the absolutely opake parts gave five parts more of carbonate of lime; and lastly, the analysis of the white coating naturally enveloping the masses, afforded 86 parts of silex, 1 oxide of iron, 10 carbonate of lime, and 3 loss. Those analyses which afforded no alumine, shew that this earth is not essential to the silex, and the absence of lime in the first analysis shews that it was an accidental ingredient in the latter.

Mineralogical situation. In France in the environs of St. Aignan, situated in the department of Loir-Cher, and in that of L'Indre, and the departments which occupy the vallies of Siene and Marne, are principally the places where this stone is found. It exists in the chalky calcareous stones, in chalks more or less fine and solid, and in marles. They form horizontal strata, by the manner in which the large and small masses are placed beside each other. Nevertheless, as the blocks of silex do not accurately touch each other, there is no solution of continuity between the upper and lower masses of chalk.

Out of twenty beds of silex lying one above the other, at a distance of twenty feet or less, there will frequently be no more than one, and very seldom two, which afford good stones of this description; but in the bed which affords them, almost all the blocks have a greasy appearance, and in the other strata scarcely any of this description will be found. Accordingly the good strata are followed

by subterraneous excavations, frequently at considerable expence, while the others are neglected.

On the banks of the Cher the flints are explored in a plain, by digging shafts to the depth of 40 or 50 feet, from whence horizontal galleries are carried into the only good stratum which is known.

On the banks of the Seine in the hills of La Roche Guion, the cliffs of chalk present steep precipices, where the strata of silex are exposed; and one of these strata, which contains good stones for gun-flints, is about six toises from the upper surface of the great mass of chalk.

Instruments.

The instruments used for fashioning the gun-flints are four in number:

1. A small piece of iron or mace, with a square head, Plate 1. Fig. 1. the weight of which does not exceed two pounds, or perhaps a pound and a half, with a handle seven or eight inches long. This instrument is not made of steel, because if it were too hard, its stroke might shatter the flint, instead of breaking it by a clear fracture.

2. A hammer with two points, in which the position of the points is of consequence as to the nature of the stroke, Fig. 2. This hammer, which must be of good steel well hardened, and does not weigh more than sixteen ounces; some do not exceed ten. It is fixed on a handle seven inches long, which passes through it in such a manner, that the points of the hammer are nearer the hand of the workman, than the center of gravity of the mass. The form and size of the hammers of different workmen vary a little, but this disposition of the points is common to them all, and is of consequence to the force and certainty of the blow.

3. A little instrument named Roulette (roller) which represents a solid wheel, or segment of a cylinder, two

inches and one third in diameter. Its weight does not exceed twelve ounces, it is made of steel not hardened, and is fixed on a small handle six inches long, which passes through a square hole in its center.

4. A chissel bevelled on both sides, seven or eight inches long, and two inches wide, of steel not hardened; it is set on the block of wood which serves as a work bench, out of which it rises to the height of four or five inches. To these four instruments we may add a file, for the purpose of restoring the edge of the chissel from time to time.

The process:

After selecting a good mass of silex, the whole operation may be divided into four manipulations.

1. To break the block. The workman being seated on the ground, places the flint on his left thigh, and strikes it gently with the larger hammer, Fig. 1. to divide it into portions according to its size, that is to say, of about a pound and a half each, with broad surfaces nearly flat. He is careful not to crack or produce shakes in the flint by striking it too hard.

2. To cleave the flint, or break it into scales. The principal operation of this art is to cleave the flint well: that is to say, to separate from it pieces of the length, thickness, and figure, adapted to be afterwards fashioned into gun-flints; and in this part the greatest degree of address, and certainty of manipulation are required. The stone has no particular direction in which it can be most easily broken. The course of its fracture depends entirely upon the choice of the workman. In this process he holds a piece of flint in his left hand, not supported, and strikes with the hammer, Fig. 2. on the broad faces produced by the first fracture, in such a manner as to chip off the white coating of the stone in small scales, and to lay bare the silex in the manner represented, Fig. 5.;

after which he continues to strike off other similar portions of the pure silex. These pieces are nearly an inch and a half wide, two inches and a half long, and one sixth of an inch thick in the middle.

They are slightly convex within, and consequently leave a space somewhat concave, terminating longitudinally in two lines, somewhat projecting, and nearly strait. The prominent edges produced by the fracture of the first scales, must afterwards constitute nearly the middle of the subsequent pieces; and those pieces only, in which they are found, can be used to form gun-flints.

In this manner the operator continues to cleave, or scale the stone in different directions, until the natural defects of the mass render it impossible to make the fractures required, or until the piece is reduced too much to receive the small blows which separate the pieces.

3. To fashion the flint.

The gun-flint, Fig. 7. may be distinguished into five parts, namely, 1. the edge, or bevel part, which strikes the hammer or steel. This is two or three twelfths of an inch in width. If it were broader it would be too liable to break, and if more obtuse it would not afford a brisk fire. 2dly. The side edges, which are always somewhat irregular. 3dly. The back edge, most remote from the hammer where the stone possesses its intire thickness. 4thly. The under surface, which is smooth and slightly convex. And 5thly. The upper face, which is slightly concave, and receives the action of the upper claw of the cock, in which it is fixed for service.

In order to fashion the stone, those scales or chips are selected, which have at least one longitudinal prominent angle. One of the two edges is fixed on to form the striking edge; after which the two sides of the stone which are to form the side edges, and that which is to form the hinder edge are successively placed with the convex sur-

face upon the edge of the chissel, which is supported with the fore-finger of the left hand, at the same time that a small blow or two is given above the point of support with the Roulette, Fig. 3. by which the stone breaks exactly along the edge of the chissel, as if it had been cut. In this manner the sides and posterior edge of the stones are made.

4. The stone being thus reduced to its proper figure, the finishing operation consists in completing its edge in a strait line. For this purpose the stone is turned, and the under flat part of the edge is placed on the chissel, in which situation it is completed by five or six small strokes with the Roulette.

The whole operation of fashioning a gun-flint is performed in less than one minute.

A good workman can prepare a thousand good chips or scales in a day, if his flints be of good quality, and he can also fashion five hundred gun-flints in a day; consequently in three days he will cleave and finish a thousand gun-flints without further assistance.

This manufacture leaves a great quantity of refuse; that is to say, about three-fourths of the whole stone. For there are not more than half the scales which prove to be well figured, and nearly half the mass in the best flints is incapable of being chipped out: so that it seldom happens that the largest piece will afford more than fifty gun-flints. The larger pieces of refuse are sold for the culinary purpose of striking a light.

The gun-flints when completed are sorted out, and sold at different prices, according to their degrees of perfection, from 4 to 6 decimes (or pence) the hundred. They are classed into fine flints and common flints; and according to their application into flints for pistols, fowling pieces, and muskets.

The fabrication and commerce of gun-flints in France

is in some measure confined to three communes of the department of Loir-et-Cher, and one department of the Indre, as was before mentioned, namely, the commune of Noyers, 2,400 metres east north-east of St. Aignan; the commune of Couffy at 5,600 metres, and that of Meunes at one miriameter east south-east, and in the latter department, the commune of Lye 9 kilometers to the south-west of St. Aignan. The inhabitants of these communes employed in this species of industry are about 800, and they have excavated great part of the plain they inhabit.

A single workman named Stephen Buffet, who emigrated from the commune of Meunes to the banks of the Seine, where he has carried on this art for about thirty years by himself, was the person from whom Dolomieu obtained the present instructions. There are a few other places in France where this art is practised, but in none to the extent of the places before mentioned. The author has not met with this manufactory in any other countries, except in the territory of Vicenza, and one of the cantons of Sicily. He remarks that it may be carried on elsewhere, though probably overlooked by travellers, on account of its apparent insignificance. I believe it is practised at Purfleet, in the county of Kent, and in various other parts of England.

No. 5.

Wooden Matches for Artillery to be used instead of Rope Match, or Port-Fires: read at the National Institute, April 1806. *By* C. L. Cadet.*

FOR several centuries rope match only was used for firing great guns, mortars, howitzers, and other pieces of artillery. This match, as is well known, is a rope of supple hemp, of a midling size, boiled for two hours in a bath of saltpetre, ashes, quicklime, and horse-dung. This rope, when dried, burns slowly to the end, in the manner of touchwood, and communicates its fire like red-hot coal. For use it is twisted round a staff called a port-match, and left to project near five inches beyond its end, this length burning an hour.

This match has several inconveniences. It requires constant attendance, since it must be unrolled from the staff every hour, or oftener; a tolerably heavy rain puts it out; it gives the artilleryman no light by night; and the end beyond the staff is not always steady, so that the gunner is slow in firing his piece. On these accounts its use is now confined to garrisons, except for carrying fire in the field, where for other purposes port-fires are employed.

These port-fires are paper tubes, filled with a mixture of sulphur, saltpetre, and a very little neat-powder. This composition, the greater part of which is saltpetre, burns and melts with great activity, giving a vivid and bright flame, which quickly sets fire to the priming. In this respect they are far preferable to match, since they give light to the gunner, their fire is more vivid, and they are more easily guided; but these advantages are counter-

* Nicholson, v. 17. p. 31. from *Annales de Chimie*, Sep. 1806, p. 314.

balanced by dangers and defects. The saltpetre in these port-fires is never entirely burnt, but part runs out of the tube. When the materials are not well powdered, they are subject to spit, or throw out pieces of burning saltpetre to the distance of three or four feet, which may occasion serious accidents, particularly on board ships. I myself had my hair set on fire, and a hole burnt through both my coats, by a spark of this kind. In ships they are obliged to be kept in the middle of a tub of water on this account.

These were the only means employed to fire pieces of artillery, when one of my correspondents at Madrid acquainted me, that Messrs. Borda and Proust had proposed to the Spanish government, to substitute instead of the cannon match, wooden rods impregnated with nitrate of copper. He added, that these rods burnt like touchwood, forming a pointed red coal; and that the trials with them succeeded perfectly, though they had not been adopted. I informed his excellency, the minister at war, of this new method; and he requested me to make the necessary experiments for ascertaining its utility, directing Mr. Lespagnol, a captain in the artillery, to assist me in the inquiry.

My first idea was, that all kinds of wood could not be equally fit for the purpose; and that the difference of their porosity would occasion a difference in their combustibility. Before I tried the metallic nitrates, I took common saltpetre, and boiled several kinds of wood in a strong solution of it, which they imbibed in different proportions. This attempt did not succeed: the only wood that burnt quickly was the common cane, used for dusting clothes, or *rotang;* but its coal had no substance, the least blow breaking it off, and extinguishing it. I then got a joiner to make me some square rods, half a yard long, of oak, elm, ash, elder, birch, poplar, lime,

and fir. I took two parcels of these, and boiled one in a solution of nitrate of copper, the other in a solution of nitrate of lead. In each, the oak, elm, ash, and elder, were not saturated, and burnt in the usual manner: the others afforded me very good matches. But before I enter at large on their properties, I shall observe, that I conceive the nitrate of copper should be rejected, because it is too dear, it quickly corrodes the boilers, and its vapour is noxious. Accordingly I confined myself to the nitrate of lead; and I found after several trials, that it answered the purpose completely.*

The wood that did best was that of the lime, birch, or poplar. To compare their properties, I weighed some rods both before and after boiling; I ascertained how much their weight was increased, and how long they continued burning; and I calculated how much of each a pound of nitrate of lead would saturate. The following table gives the proportions.

Name of the wood.	Weight of a yard before the experiment.	Weight after.	Gained in Weight.
	Grains.	Grains.	Grains.
Birch	888	1416	528
Poplar	516	936	420
Lime	888	1728	840

Name of the wood.	Length saturated by a pound of nitrate of lead.			Time each continued burning.
	Yards.	Ft.	Inches.	Hours.
Birch	17	1		3
Poplar	21	2	8	2
Lime	10	2	9	3

* If this plan should be adopted by our government, and comparative experiment should prove the nitrate of copper to be preferable to that of lead, an easy method of manufacturing that salt might be pursued, viz. the decomposition of sulphate of copper, by nitrate of potash.—Here the objections made by the author would be avoided—and the expense attending much lessened. By a small experiment made with this view, I have reason to believe every object wished for may be attained. Ed.

From this comparative trial it follows, that the lime tree affords the best wood for matches for artillery; and with it I made the experiments desired by the minister, in presence of Mr. Lespagnol.

There are circumstances in which the service of the artillery requires light. Rods impregnated merely with nitrate of lead, produce a coal sufficient to discharge a cannon, but no light is afforded by them. I conceived, that, if they were impregnated with oil of turpentine, they might yield flame, without detriment to the action of the nitrate: and my hopes were realised, for rods thus prepared furnished both light and fire at pleasure. In this addition I found two other advantages: one, that of rendering the wooden match impervious to water; the other, that of facilitating the reduction of the lead, part of which I was apprehensive might be carried off in vapour, and injure the health of those who respired it.

The theory of the process I adopted is simple; and it is easy to explain, why metallic nitrates succeed better than nitrate of potash. However dry the wood may be, it always retains a little of its water of vegetation or of composition, which is an obstacle to its proper combustion. By boiling the rods in a solution of nitrate of lead or of copper, which on account of its specific gravity requires a high temperature; this fluid dilates, softens, and penetrates the fibres of the wood, and expels their water of vegetation, which is replaced by that of crystallization. The nitrate then comes into immediate contact with the carbon of the wood, whence the rapidity of its combustion. The nitrate of potash does not answer so well, because, retaining much water of crytallization, its solution does not acquire so high a temperature: and, supposing it able to penetrate the wood as intimately, it carries into it too much water, for its combustion to be progressive and continual. A proof of this reasoning

may be found in the composition of the two salts: nitrate of lead contains .75 of its base, that of potash but .49.

The rapid combustion of the wooden match is owing also to the facility with which the salts of lead are reduced, when in contact with burning charcoal. If a hempen rope be boiled in a solution of acetate of lead, and afterward dried, it may be used as a match. It burns slowly like touchwood, and has a very bright coal. The oxide of lead, as the metal is reduced, gives out its oxigen to the carbon, and accelerates the combustion.*

On comparing the specific gravity of wood with its saturation by salts, we find, that the lighter the wood, the more saline matter it absorbs into its pores, or the interstices of its fibres. Hence it appears to me we may infer, that it contains less carbon than a heavier wood in a given bulk; and that its combustion will evolve less caloric, since the caloric emitted is in the ratio of the quantity of oxigen combined with the combustible. It seems to me, that we might class different kinds of wood, as to their combustibility, by their absorption of salts; and thus find which would be most advantageous to burn for domestic purposes, whether we would have a rapid combustion, or a stronger and more continued heat. These researches will form the subject of a particular work, which I purpose on all our forest trees.

The wooden matches, compared with port-fires, have the following advantages.

The port-fire lasts but three or four minutes.

A match a yard long will burn three hours.

The port-fire is liable to break in the boxes.

The match is strong, and easily carried about.

The port-fire throws out dangerous sparks:

* We have a familiar instance of this in the popular experiment of burning a red wafer in the flame of a candle.

The match confines its fire to itself.

The port-fire costs from three pence to four pence half-penny:

The match costs but three half-pence or two-pence.

The last consideration is of great importance, since, from calculations made in the war-office, what would cost the state in the one case a thousand pounds, in the other would not come to more than seventy-five.*

As it was necessary to ascertain, whether these new matches would resist the rain, I had several burnt during long and heavy rains, and they were not extinguished till they were totally consumed; their combustion being a little retarded only.

As the fabrication of these matches requires some care and precaution, I shall conclude this paper with a minute description of the process, agreeably to the request of his excellency the minister at war, for the instruction of the artificers employed in our arsenals.

Method of preparing the combustible wooden Matches for Artillery.—Shape of the Matches and choice of Wood.

The matches should be parallelopipedons, half a yard long, and half an inch square. The best wood for them is that of the lime tree, or birch; but for want of these, poplar or fir may be used. Any white and soft wood might be taken, if necessary; but those above-mentioned are to be preferred.

The shape might be supposed of no consequence: yet experience proves, that round matches do not furnish so good a fire as the square. The angles of the latter keep the coal in the centre burning vividly, and the match always terminates in a burning cone two inches long.

* According to the estimates just before given, the saving would be much greater than this on the lowest calculation. T.—[And still more so, if the plan proposed in a former note should be found to answer. Ed.]

Drying the Wood.

Before the matches are saturated with nitrate of lead, the wood must be perfectly dry. For this purpose the wood should have been cut and stored at least a twelvemonth; and the matches, after they are shaped, be exposed for half a day to the heat of a stove at 30° (by what thermometer is not mentioned; probably 90°, or perhaps 100° Fh.) For want of a stove they may be put into a baker's oven, when the bread is drawn.

Furnaces and Boilers.

The fabrication of the matches requires two furnaces and two boilers. The shape of the boilers should be that of a fish-kettle, narrow, and three quarters of a yard long. Their size should be proportional to the quantity to be made at a time. The furnaces should be constructed so that the heat may act uniformly on every part of the bottom of the boiler. The first boiler must be of copper, well tinned, and provided with a plate of the same metal, to press down the matches, and keep them immersed in the boiling solution. The second boiler may be either of copper or of cast iron, placed on a sand bath, and having no direct communication with the fire. It should have a lid fitted to it very closely; and handles to lift it up when necessary.

Preparation of the Nitrate of Lead.

To make this salt, nitric acid, or aqua fortis, must be saturated with red oxide of lead, or with litharge: but as it is necessary that the salt should be neutral, and have no excess either of acid or of base, some precautions in this operation are necessary. If the acid be too much concentrated, the salt will unite in a mass, crystallize confusedly, and contain a great deal of uncombined ox-

ide. If too little oxide be used, the salt will be acidulous, and soon destroy the boilers. To obtain the mean term, 500 parts of litharge should be put into a vessel of glass or earthen ware, and on this should be poured 416 parts of nitric acid at 40°, (specific gravity, we believe, 1.386) diluted with 128 parts of water; heat the mixture till the oxide is dissolved, filter, and evaporate to dryness. These proportions ought to produce 640 parts of lead.

Bath of Nitrate of Lead.

The nitrate of lead is very soluble in water, and the least possible quantity of liquid should be employed, that the bath, fully loaded, may acquire a temperature far beyond that of boiling water, and thus insinuate itself easily into the pores of the dilated wood. Accordingly, for every pound of nitrate, only a wine quart of water should be put into the boiler, or thereabout: but as different kinds of wood do not saturate themselves equally with the salt, their proportions must be studied. Experiment has shewn that to absorb a pound of nitrate of lead, requires near eleven yards of lime wood, 17½ of birch, and near 22 of poplar. The lime therefore, when saturated is the most combustible.

To render the saturation of the wood complete, six hours boiling are necessary, and hot water must be added, when the bath sinks so low as to let the salt fall to the bottom.

Second Drying of the Matches.

When the matches are taken out of the boiler, they must be carried to the stove, and made thoroughly dry, before they are put into the following bath.

Turpentine Bath.

Into the second boiler is to be put as much oil of turpentine, as will cover the matches to the depth of about an inch; and this is to be heated gently, till it begins to boil. But the moment it grows white and rises, the boiler must be covered, and quickly lifted off the sand bath, lest the oil should take fire. This boiling should be repeated two or three times, which will take about half an hour: the bath then is to be left to cool; the matches are to be taken out and wiped; and lastly they are to be dried in the stove, when they will be ready for use.

This paper was approved by the Institute, at its meeting on the 5th of May, on the report of Messrs. Carnot, Deyeux, and Guyton de Morveau.

No. 6.

[In the accounts of the numerous fires which occur in the United States, it is very common to ascribe them to the nefarious proceedings of some unknown incendiary. Although this may often be the case, yet it is incumbent upon us, before stigmatizing our countrymen with such diabolical proceedings, to ascertain, if in many instances, domestic carelessness, &c. is not the source. The following papers will tend to prove, that fires may spontaneously originate from causes little suspected—and may possibly operate in promoting due attention to prevent many fatal accidents of this description.* Ed.]

* Since I put this paper into the hands of the printer, I have seen in the last number of the Medical Repository, a paper of Dr. Seybert upon this very interesting subject of spontaneous combustion. It is my intention to bring together in this and the following numbers, all the facts which have been noticed respecting it. Their importance demands that they should be concentrated into a point. Ed.

Account of a violent Explosion which happened in a Flour Warehouse, at Turin, December the 14th, 1785; to which are added some observations on spontaneous Inflammations. By Count Morozzo.*

THE Academy having expressed a desire to have a particular account of the explosion which I mentioned to them a few days after it happened, I have made all possible haste to fulfil their desires, by ascertaining with the utmost attention, all the circumstances of the fact, so as to be able to relate it with the greatest exactness.

I shall take the liberty to add to it a short account of several spontaneous inflammations, which have happened to different substances, and which have been the cause of very great misfortunes. Although the greater number of these phenomena is already well known to philosophers, I trust the collecting them together in this place will not be displeasing, as it is impossible to render too well known facts which so strongly interest the public utility.

On the 14th of December, 1785, about six o'clock in the evening, there took place in the house of Mr. Giacomelli, baker in this city, an explosion which threw down the windows and window-frames of his shop, which looked into the street; the noise was as loud as that of a large cracker, and was heard at a considerable distance. At the moment of the explosion, a very bright flame, which lasted only a few seconds, was seen in the shop; and it was immediately observed, that the inflammation proceeded from the flour-warehouse, which was situated over the back shop, and where a boy was employed in stirring some flour by the light of a lamp. The boy had

* Repert. of Arts, vol. ii. p. 416. From the Memoirs of the Academy of Sciences of Turin.

his face and arms scorched by the explosion; his hair was burnt, and it was more than a fortnight before his burns were healed. He was not the only victim of this event; another boy, who happened to be upon a scaffold, in a little room on the other side of the warehouse, seeing the flame, which had made its passage that way, and thinking the house was on fire, jumped down from the scaffold, and broke his leg.

In order to ascertain in what manner this event took place, I examined, very narrowly, the warehouse and its appendages; and, from that examination, and from the accounts of the witnesses, I have endeavoured to collect all the circumstances of the event, which I shall now describe.

The flour-warehouse, which is situated above the back shop, is six feet high, six feet wide, and about eight feet long. It is divided into two parts, by a wall; an arched cieling extends over both, but the pavement of one part is raised about two feet higher than that of the other. In the middle of the wall is an opening of communication, two feet and a half wide, and three feet high; through it the flour is conveyed from the upper chamber into the lower one.

The boy, who was employed, in the lower chamber, in collecting flour to supply the bolter below, dug about the sides of the opening, in order to make the flour fall from the upper chamber into that in which he was; and, as he was digging, rather deeply, a sudden fall of a great quantity took place, followed by a thick cloud, which immediately caught fire, from the lamp hanging to the wall, and caused the violent explosion here treated of.

The flame shewed itself in two directions; it penetrated, by a little opening, from the upper chamber of the warehouse, into a very small room above it, where, the door and window-frames being well closed and very

strong, it produced no explosion: here the poor boy, already mentioned, broke his leg. The greatest inflammation, on the contrary, took place in the smaller chamber, and, taking the direction of a small staircase, which leads into the back shop, caused a violent explosion, which threw down the frames of the windows which looked into the street. The baker himself, who happened then to be in his shop, saw the room all on fire some moments before he felt the shock of the explosion.

The warehouse, at the time of the accident, contained about three hundred sacks of flour.

Suspecting that this flour might have been laid up in the warehouse in a damp state, I thought it right to enquire into that circumstance. I found, upon examination, that it was perfectly dry; there was no appearance of fermentation in it, nor was there any sensible heat.

The baker told me that he had never had flour so dry as in that year (1785), during which the weather had been remarkably dry, there having been no rain in Piedmont for the space of five or six months: indeed, he attributed the accident which had happened in his warehouse to the extraordinary dryness of the corn.

The phænomenon, however striking at the time it happened, was not entirely new to the baker, who told me that he had, when he was a boy, witnessed a similar inflammation; it took place in a flour-warehouse, where they were pouring flour through a long wooden trough, into a bolter, while there was a light on one side; but, in this case, the inflammation was not followed by an explosion.

He mentioned to me several other instances, which I thought it my duty to enquire into; amongst them, one which had happened to the widow Ricciardi, baker in this city, where (there being, on the other side of the wall of the flour-warehouse, a lock-smith's forge) the

flour was heated to such a degree, that a boy who went into the warehouse could not remain there, so much were his feet scorched by the heat; this flour was of a dark brown colour, and whilst the people were examining it, sparks began to appear, and fire spread itself around, without producing any flame, like a true *pyrophorus.**

He also informed me, that an inflammation like that above-mentioned had happened at the house of a baker in this city, called Joseph Lambert; it was occasioned by shaking some large sacks, which had been filled with flour, near a lighted lamp, but the flame, though pretty brisk, did not do any mischief.

According to the foregoing accounts, it appears to me, that it is not difficult to explain the phænomenon in question. The following is the idea I have conceived of it: as the flour fell down, a great quantity of inflammable air, which had been confined in its interstices, was set free; this, rising up, was inflamed by the contact of the light; and, mixing immediately with a sufficient quantity of atmospheric air, the explosion took place on that side where there was the least resistance. As to the burning of the hair, and the skin, of the boy who was in the warehouse, the cause of it must be attributed to the fire of the fine particles of the flour, which, floating in the atmosphere, were kindled by the inflammable air, in the same manner as the powder from the stamina of certain vegetables, (particularly of the pine and of some mosses) when thrown into the air takes fire, if any light is applied to it.

But it may be objected, that as the flour was not at all

* I was very anxious to ascertain by experiments, whether it were possible to bring flour alone into the state of pyrophorus, but it was in vain; for though I calcined flour with a strong heat, in a small retort, with the same precautions as are used in making other *pyrophori*, I never could succeed in making it take fire by exposure to the air. By joining alum with it I obtained a true pyrophorus, as Lemery had already done.

damp, and had not any sensible degree of heat, there should not be any fermentation in it, and consequently no inflammable air should be produced: to this I answer,

First. That flour is never entirely free from humidity, as is evidently shewn by distillation.

Secondly. That although the degree of heat was not so great as to set free inflammable air by fermentation, a sufficient quantity was set free, by what may be called a mechanical mean, to inflame upon the contact of light; and to disengage, at the same time, all that which communicated with the atmospheric air.

Thirdly. We must recollect that flour also furnishes alkaline inflammable air, which is produced from the glutinous vegeto-animal part of the corn; and we know that this kind of inflammable air is of a very active nature.

After having described this singular event, I shall beg leave to collect together, in this place, all the known facts respecting spontaneous inflammations produced by different substances. A circumstantial account of these phænomena cannot but be very interesting to those concerned in government; not only as it may tend to prevent the unhappy accidents which result from them, but also as it may sometimes hinder the suspicion and persecution of innocent persons, on account of events which are produced merely by natural causes.

I shall not mention the inflammations caused by lightning, by subterraneous fires, and by other meteors; they are not of the nature of those of which I mean to speak, but I shall not pass over in silence the spontaneous combustions of human bodies. Though events of this kind are very rare, yet we have some examples of them recorded in the Philosophical Transactions, and in the memoirs of the academies of Paris and of Copenhagen. It is there related, that an Italian lady (the countess

Cornelia Bandi) was entirely reduced to ashes, except her legs; that an English woman called Grace Pitt, was almost entirely consumed by a spontaneous inflammation of her viscera; and, lastly, that a priest of Bergamo was consumed in the same manner. These spontaneous inflammations have been attributed to the abuse of spirituous liquors; but, though the victims of intemperance are indeed very numerous, these certainly do not belong to that number.

The spontaneous inflammation of essential oils, and that of some fat oils, when mixed with nitrous acid, are well known to philosophers; so also is that of powdered charcoal with the same acid; (lately discovered by M. Proust;) and those of phosphorus, of pyrophorus, and of fulminating gold. These substances are generally to be found only in the laboratories of chemists, who are perfectly well acquainted with the precautions which it is necessary to take, to prevent the unhappy accidents which may be occasioned by them.

The conflagration of a frigate, belonging to the Empress of Russia, in the harbour of Cronstadt, on board of which there had been no fire, shews that lamp black, by being moistened with hemp-seed oil, is capable of producing flame; this was proved by the experiments which the Academy of Petersburgh made upon the subject, by order of the Empress; and, though the gentlemen of the academy could not succeed in producing inflammation in hemp or cordage, by wetting them with the forementioned oil, it is still very probable that the terrible fire which happened in the great magazine of cordage at Petersburgh, was occasioned by the spontaneous inflammation of these substances; and also that which happened at Rochefort in the year 1756.*

The burning of a store-house of sails, which happen-

* A more particular account of several of these facts, will appear in our subsequent numbers. Ed.

ed at Brest, in the year 1757, was caused by the spontaneous inflammation of some oiled cloths, which, after having been painted on one side, and dried in the sun, were stowed away while yet warm, as was shewn by subsequent experiments.*

Vegetables boiled in oil or fat, and left to themselves, after having been pressed, inflame in the open air. This inflammation always takes place when the vegetables retain a certain degree of humidity; if they are first thoroughly dried, they are reduced to ashes, without the appearance of flame. We owe the observation of these facts to MM. Saladin and Carette.†

The heaps of linen rags which are thrown together in paper manufactories, the preparation of which is hastened by means of fermentation, often take fire if not carefully attended to.

The spontaneous inflammation of hay has been known for many centuries; by its means, houses, barns, &c. have been often reduced to ashes. When the hay is laid up damp, the inflammation often happens; for, the fermentation is then very great. This accident very seldom occurs to the first hay, (according to the observation of M. de Bomare,) but is much more common to the second; and if, through inattention, a piece of iron should be left in a stack of hay in fermentation, the inflammation of that stack is almost a certain consequence. On this subject, an excellent memoir of M. Sennebier‡ may be consulted. Corn, heaped up, has also sometimes produced inflammation of this nature; Vanieri, in his *Prædium Rusticum*, says,

Quæ vero (gramina) nondum satis insolata recondens
Imprudens, subitis pariunt incendia flammis.

* See Mémoires de l'Académie de Paris. 1760.

† Journal de Physique. 1784.

‡ Journal de Physique, 1781.

Dung also, under certain circumstances, inflames spontaneously.

We have likewise examples of spontaneous inflammations in the productions of the animal kingdom. Pieces of woollen cloth, which had not been scoured, took fire in a warehouse. The same thing happened to some heaps of woollen yarn; and some pieces of cloth took fire in the road as they were going to the fuller. These inflammations always take place when the matters heaped up preserve a certain degree of humidity, which is necessary to excite a fermentation; the heat resulting from which, by drying the oil, leads them insensibly to a state of ignition; and the quality of the oil, being more or less desiccative, very much contributes thereto.

The mineral kingdom also often affords instances of spontaneous inflammation. Pyrites heaped up, if wetted and exposed to the air, take fire. Pit-coal also, laid in heaps, under certain circumstances, inflames spontaneously. M. Duhamel has described two inflammations of this nature, which happened in the magazines of Brest, in the years 1741 and 1757.*

Boats loaded with quick lime have taken fire as they sailed along; and lime, by being wetted, has often set fire to substances which happened to be near it.

Cuttings of iron, which had been left in water, and were afterwards exposed to the open air, gave sparks, and set fire to the neighbouring bodies. For this observation we are obliged to M. de Charpentier.

The explosion of a powder mill, which happened in the year 1784, in the royal manufactory of Turin, the cause of which could not be discovered, may perhaps have been occasioned by the spontaneous inflammation of the ingredients of which gunpowder is made, as Count de

* Mémoires de l'Académie.

Saluces suspected. I do not however deny the possibility of its having been caused by the meteor which was supposed to have been the occasion of it; for, there is a kind of hepatic air continually arising from those ingredients, when wetted with water, and the least flame is sufficient to kindle this aëriform vapour.

It is very evident, from the facts which I have related, that spontaneous inflammations being very frequent, and their causes very various, too much attention and vigilance cannot be used to prevent their dreadful effects. And consequently it is impossible to be too careful in watching over public magazines and storehouses, particularly those belonging to the ordnance, or those in which are kept hemp, cordage, lamp-black, pitch, tar, oiled cloths, &c. which substances ought never to be left heaped up, particularly if they have any moisture in them. In order to prevent any accident from them, it would be proper to examine them often, to take notice if any heat is to be observed in them, and, in that case, to apply a remedy immediately. These examinations should be made by day, it not being advisable to carry a light into the magazines, for, when the fermentation is sufficiently advanced, the vapours which are disengaged by it, are in an inflammable state, and the approach of a light might, by their means, set fire to the substances whence they proceed.

Substances in fermentation are very often unable to inflame of themselves, but the simple contact of flame is sufficient to kindle them rapidly, as many examples demonstrate; so that we might make a separate class of those substances in which inflammation cannot take place of itself, but which are set on fire by the approach of flame; of this we have an example in the accident which happened in the flour-warehouse.

Ignorance of the fore-mentioned circumstances, and a

culpable negligence of those precautions which ought to be taken, have often caused more misfortunes and loss than the most contriving malice; it is therefore of great importance that these facts should be universally known, that public utility may reap from them every possible advantage.

[*To be continued.*]

No. 7.

Description of a moveable Table, for the Use of Engravers; invented by the Abbé JOSEPH LONGHI, *of Monza.**

With an Engraving.

THE art of engraving upon copper, which was at first invented to multiply and preserve copies of the best pictures of the most able painters, and portraits of the most famous men, and which has ever since its invention been much esteemed, is at present in such repute in every civilized nation, that its productions are become of great consequence, even when considered as an article of commerce; and, when this art is followed by young men who have both an iuclination and a genius for it, what advantage may it not produce to their country, and to society in general? But it often happens, as history testifies, that those artists who apply the most assiduously to it fall early victims to their assiduity, so that their first essays become their last works. I myself remember, with great concern, several who have been taken from this world by a death more or less premature. Considering what could be the cause of this evil, as it was by no means difficult to discover, I found it to proceed from the

* Repert. of Arts, vol. v. p. 354. From the Transactions of the Patriotic Society of Milan. A gold medal was given to the Abbé Longhi for this invention.

Fig. 1.

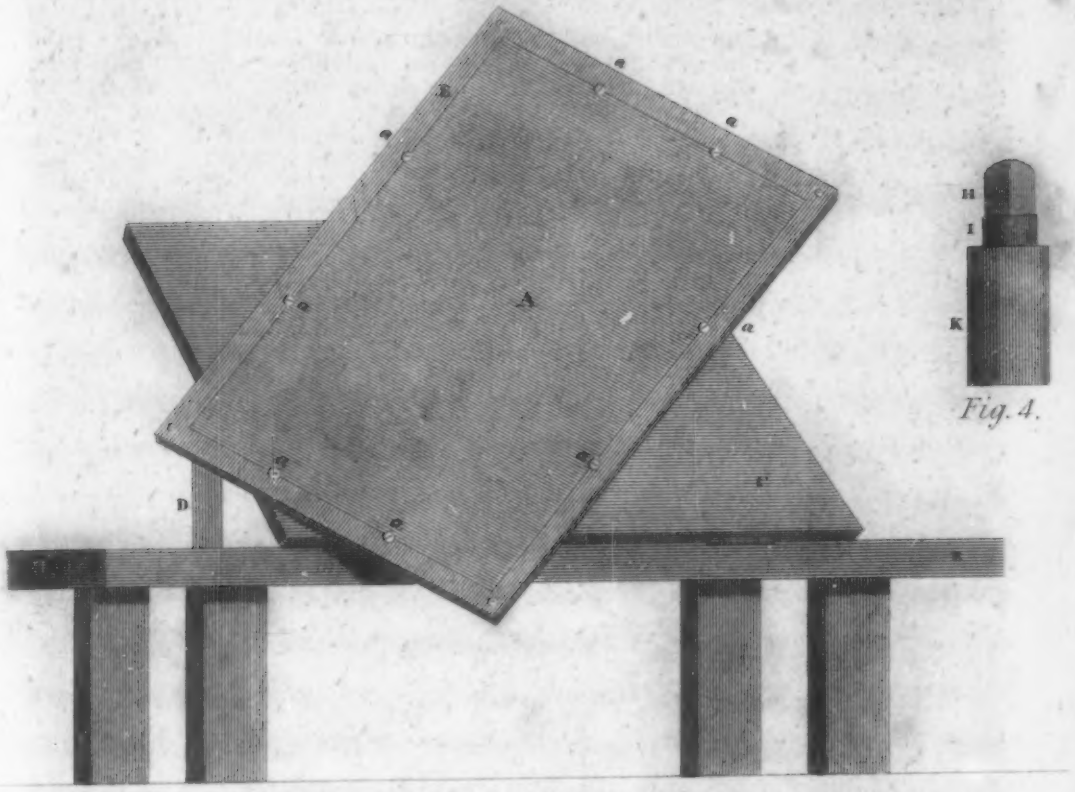


Fig. 4.

Fig. 2.

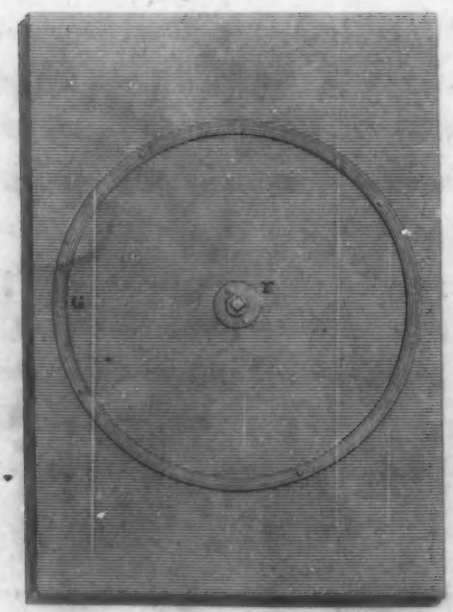
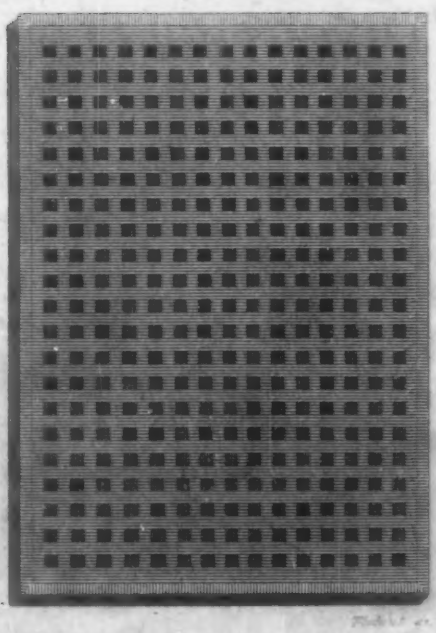


Fig. 3.



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very hurtful attitude in which the engraver is placed while he is at work; for, in engraving a plate, even of a middling size, if the plate be placed horizontally upon a cushion, as is usual, it is impossible to perform the work without a very injurious curvature of the body; which, by being repeated as often as is necessary in the course of the operation, lays the foundation of those complaints which so often prove fatal to artists. It is however certain that, besides this cause, many others may have contributed to those disorders which have deprived us of many excellent engravers, but the most evident cause is in the art itself. Wherefore, instead of being surprised at their unhappy fate, I cannot help considering those who have lived to an advanced age as wonderful instances; a very strong constitution, (which, however, is seldom the lot of those who have great talents) taking exercise, less assiduity in their labour, and a power of performing their work without carrying their eyes very near it, may have exempted them from the common fate of their fellow-artists.

Instead of trusting to these infrequent examples, I thought I should do a more useful thing by contriving such a table, for the use of engravers, as is here described. My intention was that those artists should be able to work, either standing or sitting, without bending the body; for that reason I began by placing the copperplate upon a desk. It was then necessary to be able to turn it about as occasion required: for this purpose, a pivot or axis in the centre, upon which it might revolve, would suffice; but I soon found that, upon one centre, it would not be possible to execute properly the various lines, in so many different directions as would be required. It became therefore also necessary that the board, upon which the plate was to be fixed, should have a great

number of holes underneath, by which it might be put upon the axis or pivot in any part, as occasion might require; and as these holes, if made of a circular form, would perhaps not be all exactly of the same size, (either from the difficulty of making them so originally, or from some of them being oftener made use of than others) which consequently would take from the machine that steadiness which the artist always finds essential to his work, I thought it would be better to make them square, and, of course, to make that part of the axis which fits into them square also. Below this square part, the axis is round, and turns in a socket, so that there is no danger of its becoming either too loose or too tight. In this manner I had a table made, and I find it to answer the purpose for which it was intended in the most complete manner. Indeed, I find it much more commodious for engraving than any other method; for, when it is necessary to engrave in the corner of a plate, if we turn the plate upon a cushion, and support it with the left hand, (as is the usual way,) that hand finds it difficult, from the weight of the plate, to keep it quite motionless; and the smallest motion in the plate renders it impossible to perform the work properly, consequently that part of the plate is worse executed than the rest: but, upon my table, where the plate is fixed upon a pivot or axis, and supported by a projecting part under it, the left hand has much less to do, and the plate always turns round parallel to what it rests upon.

Thus I have given an account of the motives which induced me to contrive this table, and of the manner in which I have executed it. It has been approved by Signor de Vangelisty, professor of engraving at Milan, (who, upon seeing it, immediately made trial of it) and by the Imperial Academy of Vienna; I therefore take

the liberty to present the foregoing account of it to the Patriotic Society, with a figure of it, trusting it will be found not less useful to artists than to the art itself.*

Plate 2. fig. 1. represents the whole machine, as it is used.

A. Copper-plate on which the engraving is to be made.

a a a a a a a a. Screws by which the plate is affixed to the movable board B.

B. The upper or movable part of the table. It consists of a thin plank, to the bottom of which is united the iron plate represented in Fig. 3.

C. The under-board, which is made to rise and fall at pleasure, in the manner of a desk, by means of a pair of hinges; in the middle of it is a pretty thick axis.

D. The foot by which the desk is supported at any required height.

E. The frame of the table.

Fig. 2. The under-board or desk.

F. A circle of iron, through the middle of which protrudes that part of the axis marked H. (In Fig. 4.)

* [I am happy to have it in my power to confirm the value of the above paper, by the following testimonial of some of our best engravers. Ed.]

Philadelphia, April 27, 1812.

Sir,

We have lately seen the plan of a Table invented by the Abbé Joseph Longhi, of Monza, for the use of Engravers, and upon examination of the same, we are of opinion that the invention is not only very ingenious, but also extremely well calculated for the purpose intended. We are, sir, yours, &c.

GEO. MURRAY.
CORNs. TIEBOUT.
FRANCIS KEARNEY.
WILLIAM KNEASS.
D. EDWIN.

Dr. Coxe.

G. A larger circle of iron, of the same height as the circle F; it serves for the movable board B to rest upon, as it is turned round.

Fig. 3. The movable board B, with the iron plate fixed to it. The square holes in this plate must exactly fit that part of the axis which protrudes; and the plate itself must project so much from the board, as to take in the said part of the axis conveniently.

Fig. 4. The axis, upon a larger scale than the other figures, and out of its socket.

H. The square protruding part, which fits into the holes of the iron plate.

I. A round part, of the same size and height as the hole in the circle F, (in Fig. 2,) in which it turns.

K. A larger round part, which turns under the circle F, and is by it kept in its place.

No. 8.

VIEWS *of the* MANUFACTURES *in the* UNITED STATES; *derived from the returns made to the Treasury, pursuant to an Act of Congress, passed May 1st,* 1810. *In a Letter from* S. L. MITCHILL, *to the Hon.* THOMAS NEWTON, *dated Washington, January 7,* 1812.*

DEAR SIR,

THE act further to alter and amend the act providing for the third census or enumeration of the inhabitants of the United States, passed May 1, 1810, made it the duty of the several marshals, secretaries, and their assistants, while they were taking the census of the people, to take also, under the direction of the secretary of the treasury, and according to the instructions he should give, an ac-

* From the American Med. and Philos. Register, vol. 2. p. 405.

count of the several manufacturing establishments and manufactures within their several districts, territories, and divisions. It was directed that the whole of the information so collected should be returned to the secretary of the treasury. It was enacted too that for such additional services, suitable compensation should hereafter be made by law. The money appropriated for counting the inhabitants and registering their manufactures, was one hundred and fifty thousand dollars, which is understood to have been more than enough to defray the whole cost.

Agreeably to the request of the committee of commerce and manufactures, I have paid some attention to the returns made by the marshalls on the state of manufactures in our country. They abound with information; though some of them are executed with greatly more care and exactness than others. Massachusetts appears to have been done with remarkable correctness and method, by counties and towns. The partial accounts are followed by a general recapitulation; and the whole is an example of order and perspicuity exceedingly creditable to Mr. Prince. South Carolina, on the contrary, is an example of carelessness beyond any of the returns. It is deficient in many important respects; and seems to have been sent away in such a hurry, that the columns of figures are not added together into an aggregate sum at the foot.

The information collected in the other states, evinces intermediate degrees of observation and accuracy. Yet it ought to be mentioned of New-Jersey, a state famous for industry and manufactures, that the county abstracts only are forwarded, without any summary whatever of the whole. To render the statement instructive, the reader must bestow the labour of forming the general conclusion; and in attempting this, he will discover fre-

quent instances of incompleteness or inaccuracy. With this may be contrasted the return from Pennsylvania, which evinces an extent of research, on the part of Mr. Smith, honourable to him as an officer, and exhibits the manual arts and trades of the commonwealth to which he belongs, in a highly advantageous light. Their numbers and kinds are displayed with extraordinary detail, both as to the branches carried on and capital employed.

I nevertheless undertook the task of making a general abstract, and of deducing a sort of comprehensive table. I began with the return of Mr. Curtenius, from New-York, and entered the total sums of his several articles in one line upon a sheet of paper. There I recorded the 867 tanneries, 491 distilleries, 42 breweries, 33,068 looms, 467 fulling-mills, 413 carding machines, 26 cotton manufactories, 28 paper-mills, 124 hatteries, 6 glass-houses, 2 powder-mills, 18 rope-walks, 10 refineries of sugar, 28 oil-mills, 11 blast-furnaces, 10 air-furnaces, 44 cut-nail manufactories, and 48 forges, with some other things, particularly the cloths manufactured in that extensive commonwealth. On attempting, however, to arrange the other returns under the same heads, I found great difficulties in the way. For, though Connecticut, North Carolina, Kentucky, and indeed most of the states and territories, corresponded very well to a certain number of titles, yet many of the latter were so difform and various, that it was impossible to class them under corresponding heads.

There were further difficulties. Maine was observed by a different officer from him who took the census of Massachusetts. The return from that district is so unlike the one made by the other marshal, that it is extremely difficult, if not impossible, to make them correspond and harmonize. I despaired, therefore, of effecting a reconcilement in the returns from the two parts of Mas-

sachusetts. Again; Tennessee is in very much the same situation. The marshal of the western district of that state has made a valuable return; his colleague of the eastern district has not equalled him in particularizing and distributing his subject, and besides, has pursued so different a plan that it is not practicable to adapt them.

I might easily make other observations. The return from Rhode-Island might be quoted for its minuteness and accuracy. But, notwithstanding the appearance of observation and fidelity which pervades it, there is almost or quite an impossibility of adjusting its materials with those contained in the other returns. The like remark applies to Ohio, though its return contains indications of perspicacity and intelligence; and to Michigan, whose secretary, Atwater, has furnished a paper which, though small, is a model of perspicuity and neatness.

After several attempts to arrange and methodize the materials, so as to bring them into one compendious view, I became convinced that my labours were fruitless, and abandoned the undertaking. It is certainly a subject of regret that a grand total cannot be formed of all the manufacturing establishments in the nation. Yet we may rejoice that so much has been done. When the next census shall be taken, we may be more successful. An exact schedule of all the subjects of inquiry ought to be formed.* These, if transmitted, to the proper officers, would direct their attention to certain and definite objects. The returns would thereby be rendered uniform, and capable of being added up into one great account, exhibiting in a concordant and uniform manner all the subjects inquired into throughout the states and territories.

Some most valuable information is derived from these returns, incomplete and heterogeneous as they are. Un-

* Not merely formed, at that period, but attended to long before, and even given to the public, that by due deliberation, the most exact and accurate formula may be chosen. Ed.

der the head of sheep, for example, we learn that Vermont contains a stock of 450,000; Massachusetts 399,182; Connecticut 400,000; and Pennsylvania 1,466,918.—Among these are included the individuals of the merino breed, and of the mixed race derived from their communication with the ordinary kind. From these premises we deduce favourable conclusions as to the food derived from their carcasses, the leather from their skins, and above all the clothing from their fleeces.

The number of looms, and of carding and spinning machines, almost exceeds belief, as does also the amount of cloth prepared by the inhabitants. The woollen manufacture has prodigiously increased, as well in the quality and variety, as in the quantity of the goods. Such advances are already made toward supplying domestic fabrics enough to clothe the people, that but few years more will be necessary, under the existing commercial restrictions, to effect that important object.

The progress made in the preparation of cotton-twist, and of the articles into which it may be manufactured by the weaver, has been still more rapid and surprising. From a perusal of these papers, the most comfortable assurance is derived of the amount and fitness of these products of the loom, to afford a covering to man, and furniture for his habitation.

The fabrics of flax are also so far extended, and so much on the increase, as to excite the most cheering prospects of an augmented supply to our citizens, from their own proper labour and skill. The superior excellence of homespun linen is the strongest of all recommendations.

These papers contain a more distinct and interesting exhibition than we ever had before of the saltpetre manufactured in the states. Thus Virginia prepares 59,175 pounds; Kentucky 201,937; Massachusetts 23,600;

East Tennessee 17,531; and West Tennessee, chiefly in Jackson, Warren, White, and Smith counties, 144,895; making nearly half a million pounds of home-made nitre, as good as that usually brought from foreign parts. It is alleged, the quantity may be increased to any desirable amount. The connexion of this with numerous manufactories of gun-powder, puts us quite at our ease as to the nitrate of potash, and to the means we possess of compounding it.

The manufacture of straw is eminently worthy of notice. In Massachusetts, where the forming of bonnets from that material seems to have first begun, the yearly amount of the sales is not less than $ 551,988. The manufacture of straw bonnets has been since undertaken in Connecticut, and produces the yearly value of $27,100; and it is worthy of remark, that the labours of two women in New-Jersey, in the same way, yielded them $140, amounting to the sum of $579,228, for the single article of straw bonnets.

Nor is the preparation of sugar from the juice of the maple-tree unimportant. Of this domestic sweet, Ohio produces, in a twelve-month, 3,023,806 pounds; Kentucky, 2,471,647; Vermont, 1,200,000; and East Tennessee, 162,340: making a quantity of nearly seven million pounds in these states only, wherein the returns may be conceived to be greatly within the truth.

Works in horn, ivory, and shell, have made a progress that is worthy of notice. The combs, for instance, which Connecticut prepares annually for market, are estimated at $70,000; Massachusetts $80,624; and Pennsylvania $6,240; equalling a sum of $156,864.

I may mention too the abundance of copperas which West Tennessee and Vermont afford. The quantity per annum from the former, is stated at 56,000 lbs.; and from the latter, at 8,000. The quality of these sulphates

of iron is declared to be very fine, and that druggists and dyers may be supplied to any demand they may make.

The tanning of skins is displayed, in these surveys, to great advantage. Indeed, among a people who universally wear shoes of leather, and a great part of whose male inhabitants dress in boots, the consumption of that material is extravagant. By admitting hides and peltry free of impost, and laying heavy duties upon the introduction of tanned and rawed leather, Congress has given ample protection to the operations of preparing skins for use. But our domestic supplies go far beyond the demand for the feet and legs. Saddlery, harness, and books, are principally supplied from the same internal source, to the great extent of their several demands; and the like may be observed of the supplies for the wants of navigation and military equipments.

A prominent feature in the face of this performance is the number of stills employed in the preparation of ardent spirits. The quantity of ardent spirits annually distilled appears, by the returns, to equal the prodigious amount of twenty-three millions seven hundred and twenty thousand gallons. The extraction of brandy from peaches, of an alkoholic liquid from cider, and of whiskey from rye, and even maize, is carried to this alarming excess. These products of the distilleries are chiefly consumed among ourselves, though a portion of the latter is converted to gin before it reaches the human stomach. While, therefore, we observe the increase of these home-made fluids, we must reflect on their inebriating effects. It cannot be disguised, that their intoxicating quality recommends them to such general employment. Nor ought it to be concealed, that in a country where a gallon of this maddening stimulus can be bought for half a dollar, a gill may be obtained at retail for three cents, and the seller, at the same time, more than double

his money. The fondness for this bewitching beverage, and the repugnance to any excise upon it, raise in the mind a curious association between the free use of it and of political freedom. And it deserves the consideration of all the thinking part of society, how far disease, idleness, immorality, and other mischiefs incidental to strong potation, may not degrade freedom to rudeness and something worse.

A few other important objects disclosed by an examination of these papers, remain to be mentioned.

The number of water and horse-mills employed in spinning cotton, on this exhibition, amounted to 330, in the month of August, 1810, and working one hundred thousand spindles. These, on an average, will spin annually between four and five million pounds of yarn; and that yarn would be sufficient to weave eighteen millions of yards of cotton cloth, three quarters of a yard wide. And this is wholly independent of what may be spun in private families, although it makes part of what is wove there.

The fulling mills returned amount to 1630; and the wool-carding machines, going by water, to 1585.

The number of looms returned exceeds 330,000; and the total number of yards of cloth made of wool, cotton, and flax, as returned, exceeds seventy-five millions.

Gun-powder mills are enumerated to the number of 207. Some of these are, indeed, small; but they count, and, in addition to the larger ones, they prepare yearly 1,450,000 pounds of gun-powder.

Five hundred and thirty furnaces, forges, and bloomeries, are enumerated.

The paper mills amount to 190.

I cannot forbear to express the wish, that these important papers may fall into the hands of some person who may have time and ability to derive from them more extensive information than I am able to give you. But

until this shall be done, the present communication may serve to afford some idea of the manner in which the marshals have executed their instructions, and of the facts which their returns contain.

Allow me to assure you, once more, of my great esteem and regard,*

SAMUEL L. MITCHILL.

No. 9.

[The subject of patents having of late been brought forward in congress, the following remarks &c. may not be irrelevant at this period. The great number of patents annually granted by the United States, renders it proper for every person to be in some measure acquainted with the intention of government in thus securing to every man the reward due to his ingenuity. There can be, however, little doubt, that many of the patents thus obtained, would not be capable of sustaining a just claim for the exclusive privileges acquired; and as the public is really injured under such circumstances, any observations tending to place the business of patents in a proper light, cannot but be useful.]—Ed.†

[Remarks of the Editors of the Retrospect of Philosophical, &c. Discoveries, in relation to Patents, vol. 5. p. 554.]

"The perusal of this specification induces us to advert to the opinion entertained and acted upon by many patentees, namely, that it is only necessary to describe the principle of an invention, without minutely explaining

* It would be very acceptable to the Editor to receive from the different states, complete statistical tables, founded on the returns of the late census. Such communications cannot fail of being in the highest degree interesting, as well as of great importance to all classes of society.

† It is proposed to introduce into the Emporium a list of all the patents which have been granted in Great Britain since the year 1796, in regular succession; and also those which have issued in the United States, by which reference may readily be made to the respective papers in order to check any improper proceedings which may take place on the part of patentees for similar objects.

the construction of the machine founded upon it. As it is the plan and object of this work to afford information on every point connected with patents, for inventions, we deem it consistent with that view to introduce a few remarks, tending to show the fallacy and danger of such an opinion.

The law, permitting to the Crown the privilege of granting patents of monopoly for new inventions, is intended for the public benefit; the reward it offers is held out as an incitement to call genius into exertion for the advantage of the community. Every patentee ought to bear in mind, that the monopoly granted him is the price paid by the public for his discovery, and the patent is made on condition of the public being put in complete possession of it, that is to say, the specification required by the letters patent must be made in such manner, that a competent workman may be enabled to construct a machine capable of performing what the title sets forth, without any invention of his own, and without requiring any further instruction than what the specification affords. As the validity of the patent depends on the correctness of the specification, it behoves the patentee to bestow all his care and ability on this object.

To draw up a specification, which shall contain a luminous and minute description of the machine, without limiting the patentee's privilege to any particular modification of the principles on which it is founded, is a task which requires not only talents and technical knowledge, but great experience in the nature of patent-right; and those who have such an undertaking before them, will do well to avail themselves of any assistance they can procure to contribute to its being ably done; for, provided an invention be original, the patentee's security can be affected by nothing but an injudicious or imperfect specification.

[It is evident that these remarks will apply with equal force to patents of every other nature.]—Ed.

List of Patents that have been taken out of the office of the Secretary of State, from July, 1790, specifying the subject of the Patents, with their dates, and the names of the Patentees.

1790.

Samuel Hopkins, July 31, making pot and pearl ashes.

Joseph Stacey Sampson, August 6, manufacturing candles.

Oliver Evans, December 18, manufacturing flour and meal.

1791.

Francis Bailey, January 29, punches for types, &c. &c.

Aaron Putnam, January 29, improvement in distilling.

John Stone, March 10, driving piles for bridges.

Samuel Mulliken, March 11, machine for threshing grain and corn.

Samuel Mulliken, March 11, breaking and swingling hemp, &c.

Samuel Mulliken, March 11, machine for cutting and polishing marble, &c.

Samuel Mulliken, March 11, machine for raising a nap on cloths, &c.

George Parkinson, March 17, machine for spinning flax, hemp, &c.

Jonathan Dickerson, July 30, improvement in tide mills.

Samuel Briggs, sen. and jun., August 2, machine for making nails.

William Thomson, August 2, machine for threshing wheat, &c.

Robert R. Livingston, August 4, diminishing the friction of spindles.

John Biddis and Thomas Bedwell, August 10, making the extracts of barks.

Ludwig Conrod Kuhn, August 10, improved bedstead.

Peter Gordon, August 10, manufacturing boots.

Henry Voight, August 10, propelling boats by cattle.

Henry Keyser, August 10, manufacturing gunpowder.

James Macomb, August 26, horizontal water wheels for mills.

James Rumsay, August 26, Improvement of Dr. Barker's mill.

Jamey Rumsey, August 26, improved mode of working mills.

James Rumsey, August 26, Improvement of Savary's steam engine.

James Rumsey, August 26, Bellows.

James Rumsey, August 26, generating steam.

James Rumsey, August 26, Propelling boats or vessels.

John Fitch, August 26, Propelling boats, &c. by steam, &c.

Nathan Read, August 26, Improved boiler of the steam engine.

Nathan Read, August 26, Improvement in distilling.

John Stevens, jun. August 26, Boiler for generating steam.

John Stevens, jun. August 26, Improvement in captain Savary's steam engine.

John Stevens, jun. August 26, application of steam to work bellows.

Englehart Cruse, August 26, Improvement of Savary's steam engine.

Peter Zacharie, November 24, Machine for clearing docks or harbours.

William Pollard, December 30, Machine for spinning cotton.

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*List of English Patents for Inventions, &c.**

William Whitmore, of Birmingham; for an improvement in machines for weighing waggons, &c. Dated January 4, 1796.

Gabriel Wright, of Leadenhall-street; for improvements in azimuth compasses. Dated January 19, 1796.

Jasper Augustus Kelly, of the Strand; for improvements in the construction of harnesses, &c. Dated January 19, 1796.

Edward Thomas Jones, of Bristol; for a new method of keeping accounts. Dated January 26, 1796.

James Stuard, of St. Anne's, Limehouse; for an anchor for ships, &c. Dated February 4, 1796.

Joseph Creswell, of St. George's, Hanover square; for an improved pump. Dated February 4, 1796.

William Paul, of Manchester; for a new machine for printing and staining calicoes, &c. Dated February 4, 1796.

Edward Cook and Richard Eva, of Falmouth; for an apparatus for taking observations and altitudes, &c. Dated February 9, 1796.

William Rudder, of Birmingham; for a method of making metal-cocks, so as to prevent leakage. Dated February 16, 1796.

John Grimshaw, of Strines-Hall, Derbyshire; for the discovery of certain vegetable substances for bleaching, &c. Dated February 17, 1796.

Richard Scantlebury, of Redruth, Cornwall; for a new invented bucket for raising or drawing liquids, &c. Dated February 17, 1796.

* Repert. of Arts, vol. vi. p. 359, &c.

Joseph Hately, of Worcester; for a method of making, from vegetable bodies, a new astringent acid liquid. Dated February 19, 1796.

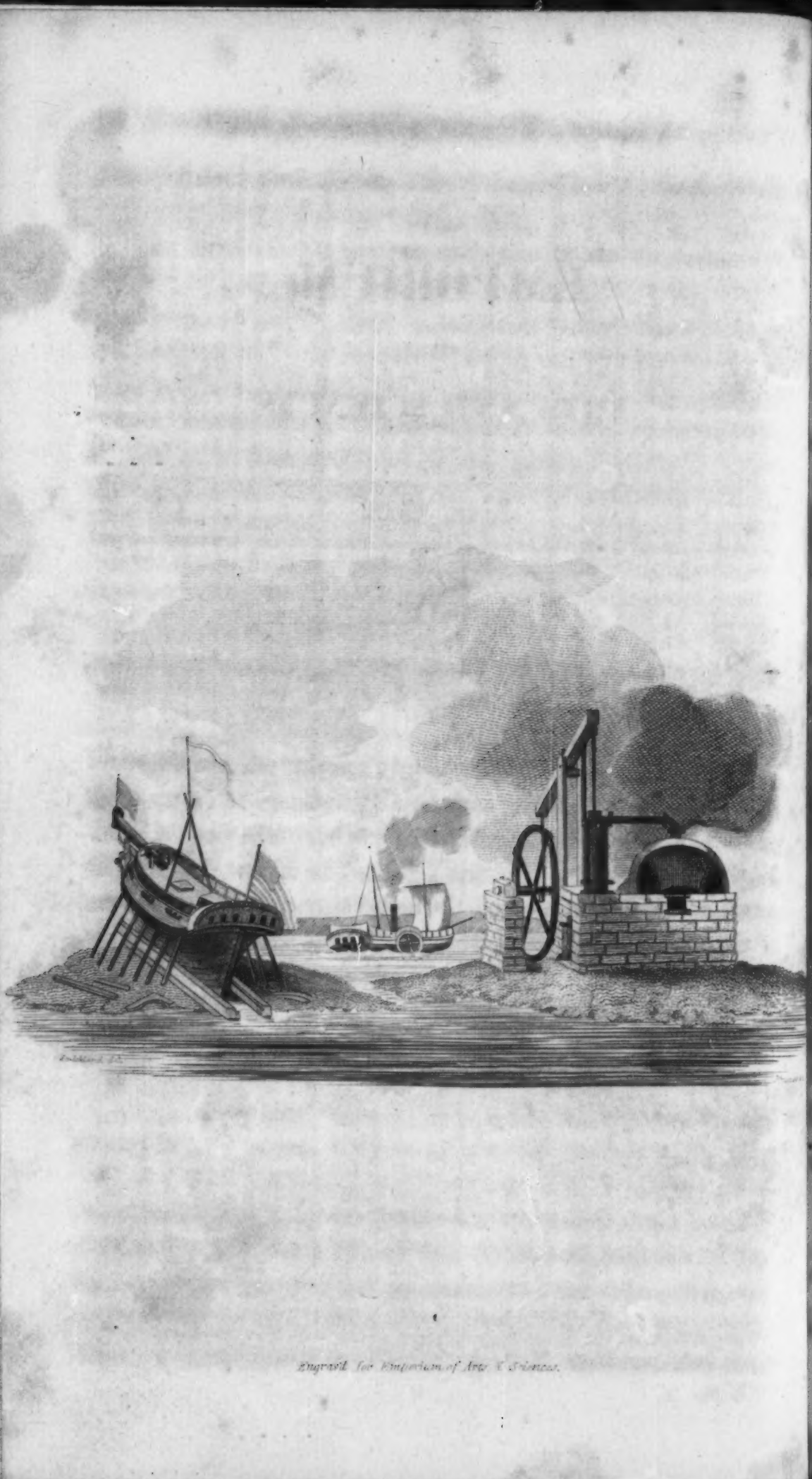
Felton Matthew, of Three Cranes Wharf, London; for a method of separating the beer from yeast, and preserving the yeast. Dated February 22, 1796.

Henry Clay, of Birmingham, Esq.; for a carriage or machine for the conveyance and shooting of coals, lime, &c. Dated February 27, 1796.

New Process for refining Sugar.

A valuable and simple process has lately been discovered by Edward Howard, Esq. F. R. S. for refining sugar, which promises to be of great advantage. The following is an outline of the process, but a more detailed account of it may be expected to be published by that gentleman himself:—"Take brown sugar, sift it through a coarse sieve, then put it lightly into any conical vessel having holes at the bottom (like a coffee machine). Then mix some brown sugar with white syrup, that is, syrup of refined sugar, to the consistency of batter or thick cream, and pour it gently on the top of the sugar in the vessel till the surface is covered. The syrup will soon begin to percolate, and leave the surface in a state which will allow more syrup to be poured upon it, which is to be done carefully. The treacle will be found to come out at the bottom, having left the whole mass perfectly white. The first droppings are to be kept apart, as the last will serve to begin another operation. The sugar is now in a pure state, except as to its containing insoluble matter, which may of course be separated by solution in water.—The clarification is to be performed by the best pipe-clay and fuller's earth, and the addition of neutral alum, if lime be previously contained therein; the whole to be agitated together; and, if expedition be required, it should be heated to the boiling point: the fæculencies will then subside. The brown syrup may also be much improved by means of tannin and the above earths. To make the sugar into snow-white powder, it is only necessary to evaporate the clarified solution to dryness on a water-bath. To make loaves, the common methods may be resorted to, or the syrup drawn off by exhaustion, or small grains may be made according to M. Du Trone's process, *with much water*, and these grains may be cemented by hot concentrated syrup."

Tilloch, vol. 30. p. 155. Feb. 1812.



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